HAMILTON ARMY AIRFIELD
OPERABLE UNIT 1

FINAL ALTERNATIVES ASSESSMENT REPORT

Submitted to

U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland 21010-5401

May 1994

REGISTERED PROFESSIONAL ENGINEER
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723055/25-42

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13. ABSTRACT (Maximum 200 words)
The Alternatives Assessment (AA) Report describes the screening and selection of alternative technologies for remedial treatment of contaminated areas within Hamilton Army Airfield (HAA) base closure property Operable Unit 1, Marin County, California. Studies were conducted under the U.S. Army Installation Restoration Program and administered by the U.S. Army Environmental Center. HAA is almost entirely below sea level and maintained dry by a perimeter levee, drainage ditch, and dewatering pumps. Subsurface soils were found to be predominantly clay-rich, low-permeability Bay Mud. The report summarizes the nature and extent of contamination with maps and tables, develops ARARs and PRGs (Preliminary Remediation Goals) according to EPA guidance, and presents estimated soil volumes for remediation by area and type of contamination. Remedial technologies that are retained through the screening process are evaluated using the nine CERCLA criteria of protection: Human health and environmental compliance with ARARs, effectiveness and permanence, reduction of toxicity, short-term effectiveness, implementability, cost, state acceptance, and community acceptance. Comparisons of the retained alternatives are made for two property reuse scenarios, unspecified development and wetland restoration, for soil, sediment, and groundwater cleanup. The report is equivalent in scope and format to a Feasability Study under the CERCLA RI/FS process.

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF TABLES (continued)

EXECUTIVE SUMMARY

BACKGROUND

As delegated by Executive Order 12580, the U.S. Department of the Army is responsible for determining response actions, consistent with the National Contingency Plan, necessary for the abatement of contamination resulting from releases of hazardous substances at Army installations. The U.S. Army Installation Restoration Program (IRP) was designed to serve as the Army's response authority.

A portion of Hamilton Army Airfield (HAA) has been recommended for closure by the Commission on Base Realignment and Closure. To support Department of Army decisions regarding the property closure, the U.S. Army Environmental Center (USAEC, formerly the U.S. Army Toxic and Hazardous Materials Agency [USATHAMA]) is responsible for implementing environmental studies prior to property transfer.

Engineering-Science, Inc., was awarded a contract to conduct an Environmental Investigation and Alternatives Assessment (EI/AA) for the base realignment and closure (BRAC) property at HAA. This document provides the results of the alternatives assessment for areas of the HAA BRAC property that were studied in the EI.

In July 1993, the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) conditionally approved the Final EI Report (Engineering-Science 1993) contingent upon additional sampling to complete characterization of contamination at HAA (Nusrala 1993). In fulfillment of these requirements, a scope of additional environmental sampling approved by the SFRWQCB (Gregg 1994) was completed in April 1994 by the Corps of Engineers (Corps 1994). The lead regulatory agencies are now the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) and the SFRWQCB.

OBJECTIVE

The objective of the alternatives assessment is to identify, develop, and evaluate specific remedial alternatives for contaminated soil, sediment, and groundwater at various sites within HAA for two potential reuse options: 1) commercial or residential development and 2) restoration as a wetland connected to San Pablo Bay.

OPERABLE UNITS

The HAA BRAC property was divided into two operable units in April 1994 as a result of findings of the Army Corps of Engineers supplemental investigations (Corps

1994). The majority of the BRAC property was studied in the EI and is included in Operable Unit 1 (OU-1). However, OU-1 also includes five parcels that have been cleared by the Army for transfer to the General Services Administration (GSA) sale parcel. These five parcels are not evaluated in the present AA.

The following sites are included in OU-1 (see Figure 1):

Elements of Operable Unit 1

Sites Investigated in the EI

- POL Area (Parcel A1)
- Burn Pit
- Revetment Area including Engine Test Pad
- Former Sewage Treatment Plant
- East Levee Landfill
- Aircraft Maintenance and Storage Area
- Fuel lines (hardware and soils in the immediate trench excavation)
- Building 442 (Parcel A2)
- Transformers on HAA BRAC property

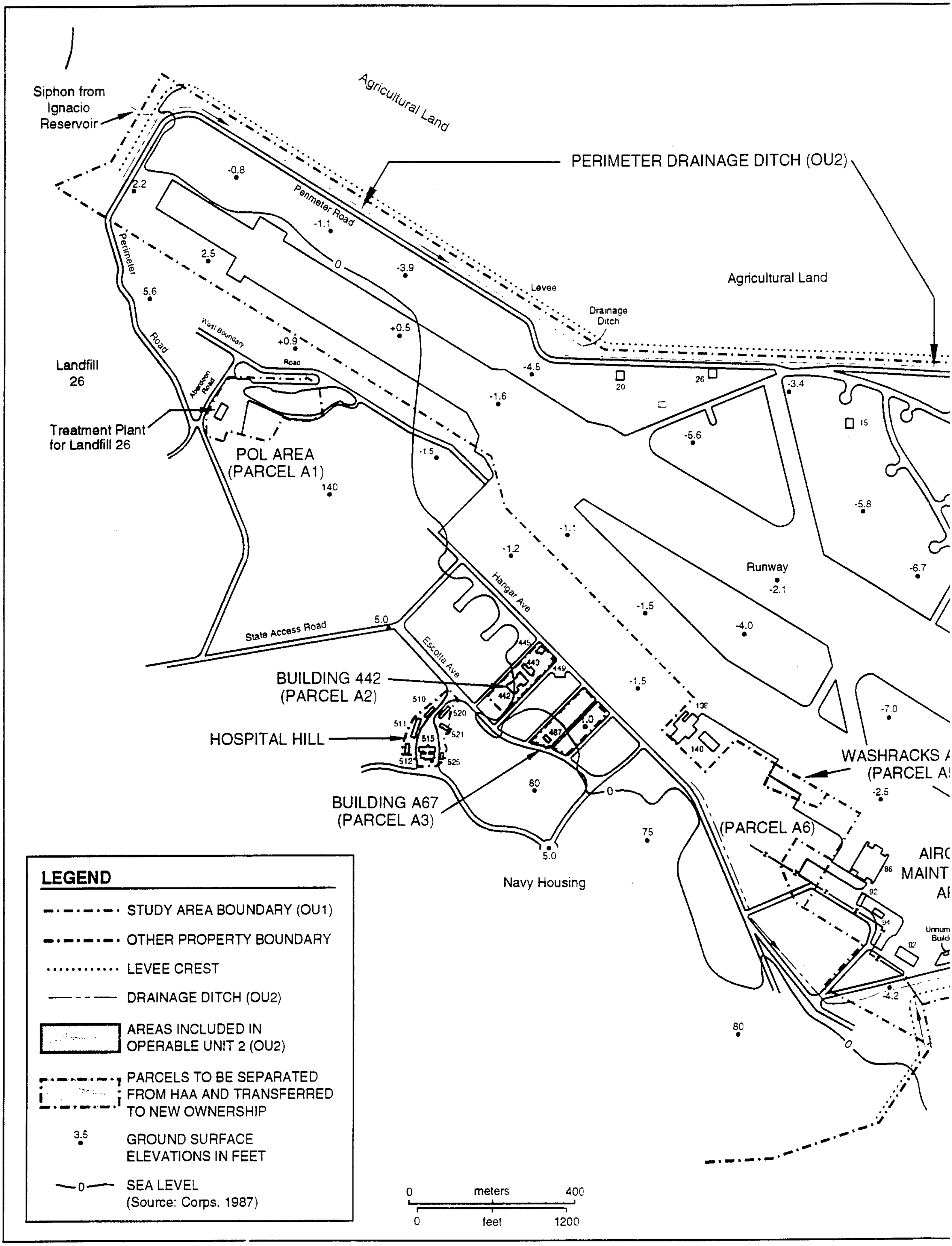
Sites Not Investigated in the EI and Not Evaluated in this AA

- Building 467 block (Parcel A3)
- Hospital Hill
- Aircraft Washrack area (Parcel A5)
- Unnamed area (Parcel A6)
- Unnumbered Underground Fuel Storage Tanks and Above Ground Tanks

The Army has performed environmental assessments and/or investigations for Parcels A2, A3, A5, and A6 for the purpose of transferring the ownership to the private sector along with the GSA sale parcel. The POL Area (Parcel A1) is to be retained by the Army. The Hospital Hill parcel is to be transferred from the Army; however, the new ownership has not yet been determined.

A principal finding of the Corps of Engineers study was that contamination of sediments in the perimeter drainage ditch and in the tidal wetlands was more extensive than had been previously assessed. Determination of cleanup levels and selection of preferred alternatives for the perimeter ditch and the tidal wetland will require further sampling and/or review by regulatory agencies.

Remedial action cannot be completed at the Pump Station AST sites in time to be included in the Decision Document process for the majority of the HAA BRAC property (OU-1). This is because the pump stations must remain in operation to keep the base dewatered until the final stage of closure. In addition, constraints on funding of base



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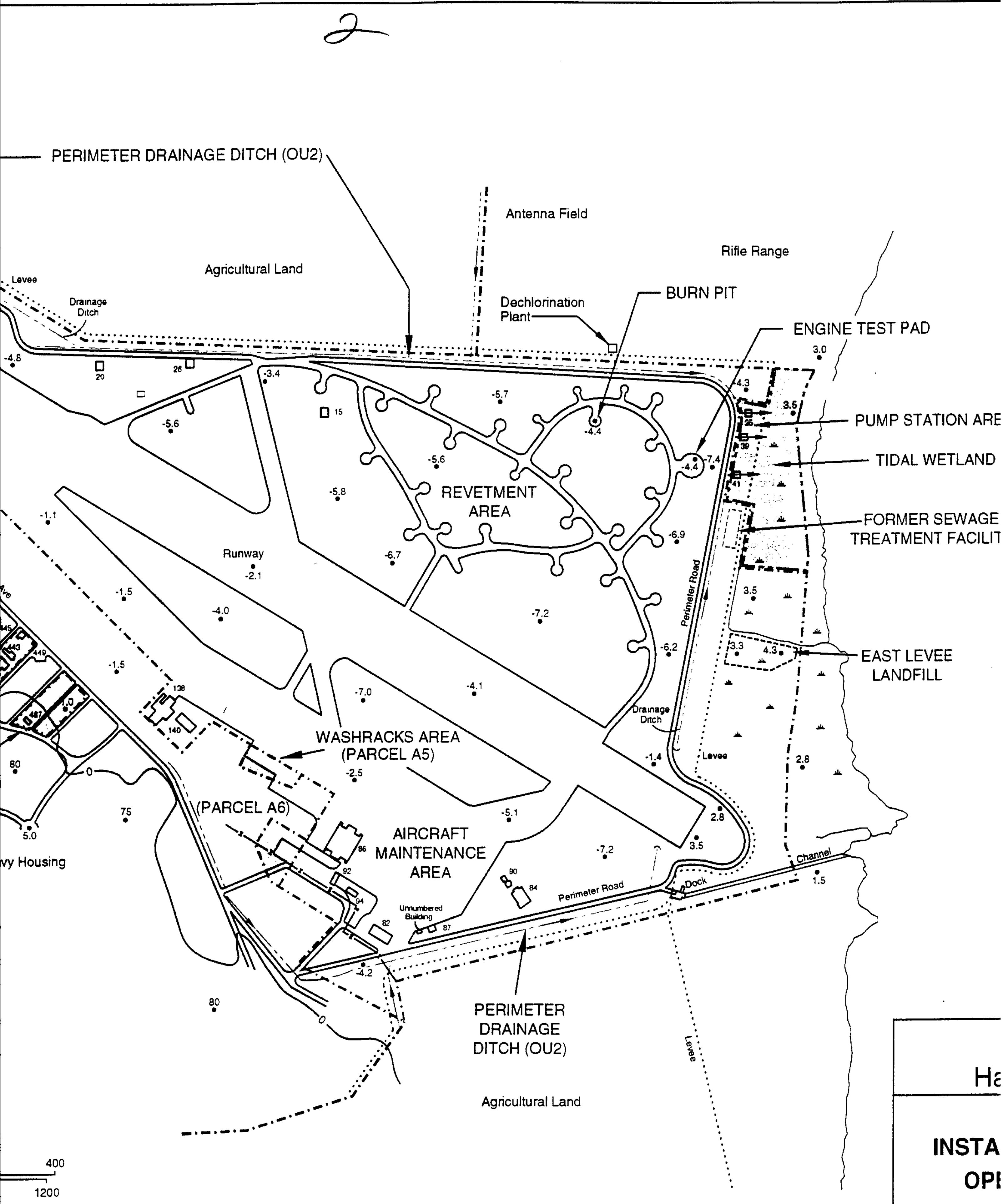

2
PERIMETER DRAINAGE DITCH (OU2)
Antenna Field
Rifle Range
Agricultural Land
Levee
Drainage Ditch
Dechlorination Plant
BURN PIT
ENGINE TEST PAD
PUMP STATION ARE
TIDAL WETLAND
FORMER SEWAGE TREATMENT FACILIT
REVETMENT AREA
Runway
Perimeter Road
EAST LEVEE LANDFILL
WASHRACKS AREA (PARCEL A5)
(PARCEL A6)
AIRCRAFT MAINTENANCE AREA
Unnumbered Building
Dock
Channel
Navy Housing
PERIMETER DRAINAGE DITCH (OU2)
Agricultural Land
Levee
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1200
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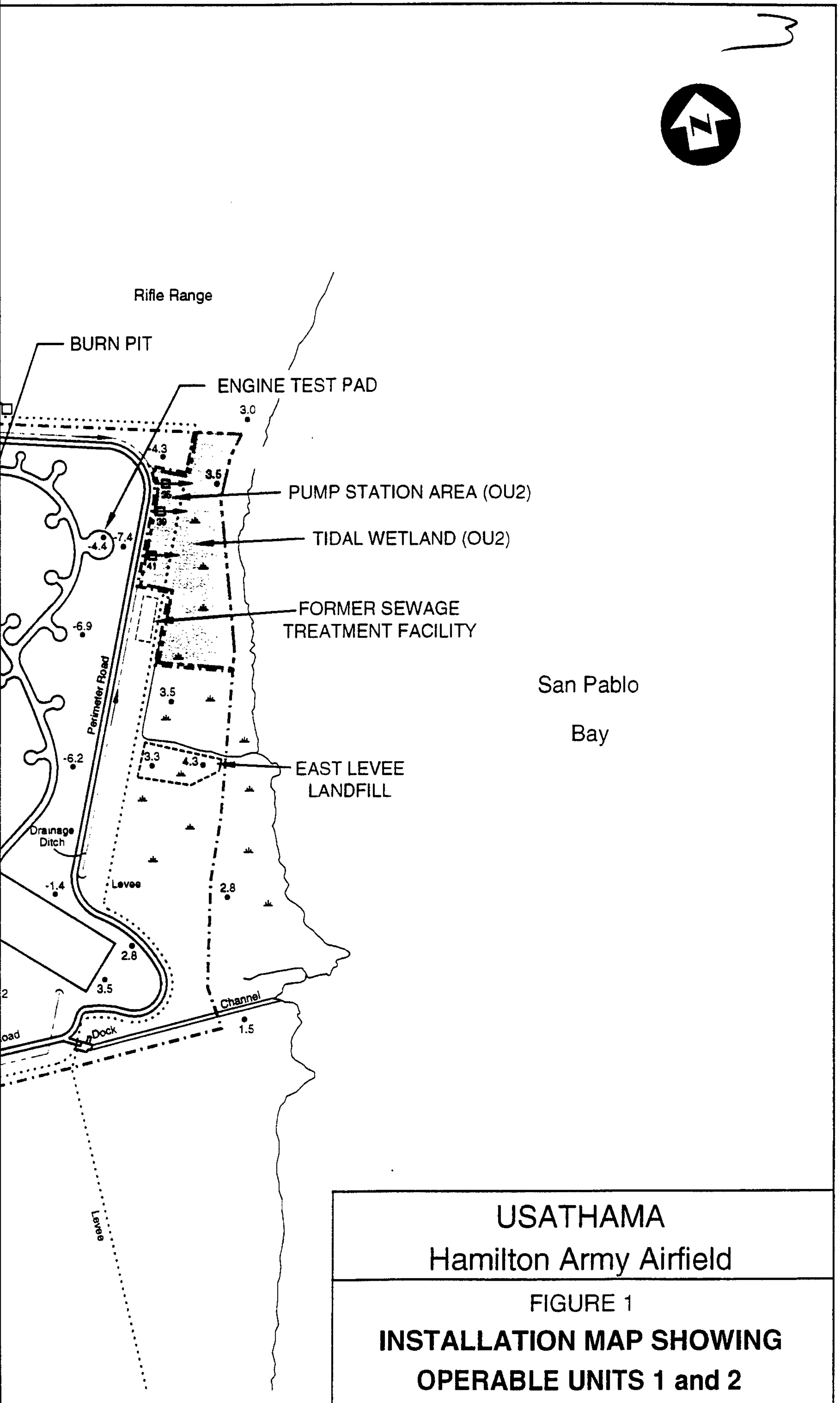

USATHAMA
Hamilton Army Airfield

FIGURE 1
INSTALLATION MAP SHOWING OPERABLE UNITS 1 and 2

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closure activities require that fuel contaminated soil that may be found in association with the Fuel Lines may not be excavated completely within the OU-1 remedial action. Therefore, remedial alternatives analysis for the following four items which are designated part of Operable Unit 2 (OU-2), has not been carried to completion in this report:

Elements of Operable Unit 2

- The tidal wetland east of the levee and opposite the Pump Station Area
- Contaminated soils at the Pump Station AST sites
- Excess contaminated soil that may be left for later excavation after removal of the Fuel Lines
- The perimeter drainage ditch both north and south of the runway

REGULATORY DETERMINATIONS

The DTSC and SFRWQCB have determined that for a future base development reuse option a soil TPH cleanup goal of 10 mg/kg would generally apply. A site-specific exception of 100 mg/kg has been made for soil and rock in the POL Area based on immobility, isolation of contaminants from potential receptors, and distance from surface water bodies.

For the wetland reuse option a soil cleanup goal of 100 mg/kg TPH has been approved. For soil concentrations between 10 and 100 mg/kg, soil may be left in place provided that it is covered with 3 feet of clean soil. Supporting correspondence is provided in Appendix J.

For soil/sediment remedial action levels for the wetland option, the SFRWQCB has approved the use of Sediment Screening Criteria for 1 screening level concentrations above which 3 feet of clean fill will be required and 2 cleanup levels above which excavation and treatment will be required. Case-specific requirements were determined for lead and nickel based on results of modified WET tests conducted by the Corps of Engineers (Corps 1994).

In the Aircraft Maintenance Area a requirement for 3 feet of clean cover fill over unpaved areas will apply regardless of future reuse option. This is to prevent any eventuality for human contact with subsurface soils which contain metals concentrations above PRG threshold levels.

Regulatory agencies have stated that further deliberation and possible revision of agreed cleanup levels may be required if a base reuse option other than the Wetland Option is selected.

METHODOLOGY

The introduction to the Alternatives Assessment (Section 1) summarizes the findings of the Final EI regarding the nature and extent of contamination, contaminant fate and

transport, and baseline risks to human health and the environment for each site area. Contaminated areas are depicted on maps in Section 1.

Section 2 of the report identifies and screens potentially applicable treatment technologies and process options. Estimated areas and volumes of contaminated soil are tabulated. This section also identifies the contaminants of concern in soil, sediment, and groundwater at each HAA site, develops ARARs for potential human and ecological receptors, and assesses background concentrations for metals.

Risk-based Preliminary Remediation Goals (PRGs) are developed as the basis for cleanup levels for the Development Reuse Option (Table 2.4). The SFRWQCB Sediment Screening Criteria are presented as the primary basis for remediation screening and cleanup levels for the Wetland Reuse Option (Table 2.6). A remediation goal of 10 mg/kg TPH is applied to the majority of the base under the Development Option. An exception was made for the soil and rock in POL Area where concentrations up to 100 mg/kg will be left in place. The TPH soil and sediment remediation goal for the Wetland Option (and for areas that would be tidal wetland under either option) is 100 mg/kg.

Section 3 develops remedial alternatives and performs preliminary screening of remedial alternatives for the HAA sites. The alternatives retained for discussion relative to the reuse options in Sections 4, 5, and 6 are as follows:

Soil and Sediment

- No Action
- Capping
- In-situ Soil Flushing
- In-situ Bioremediation
- In-situ Soil Vapor Extraction
- In-situ Bioventing
- Excavation and Biological Treatment
- Excavation and Low Temperature Thermal Desorption
- Excavation and Off-site Thermal Destruction
- Excavation and Chemical Oxidation
- Excavation and Soil Washing
- Excavation and Solidification and Stabilization

Groundwater

- No Action
- In-situ Air Sparging
- In-situ Biostimulation
- Air Stripping and Carbon Absorption

- Carbon Absorption
- Biological Degradation
- UV/Oxidation

Options and limitations for treated water discharges are discussed. The SFRWQCB's Shallow Water Effluent Limitations (SWELs) are presented and discussed as to-be-considered (TBC) criteria not applicable to OU-1 but possibly applicable to future actions in OU-2.

Sections 4, 5, and 6 of the report evaluate the remedial alternatives for each site in detail relative to soil remediation for the Development Reuse Option, groundwater remediation, and soil/sediment remediation for the Wetland Reuse Option. The nine CERCLA criteria utilized in this evaluation are as follows:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State agency acceptance
- Community acceptance

In Section 7, the remedial alternatives retained after evaluation are presented and a preferred alternative is selected for each site and for each reuse option. Estimated costs are summarized for the two reuse options and for groundwater remediation. The potential cost savings and benefits derived from centralized treatment are discussed.

CONCLUSIONS

At this time the Wetland Reuse Option appears to be the most likely scenario for base reuse because 1) no entity has committed to large repair and operating costs that would be required to upgrade and maintain the drainage network and pump stations when the Army vacates the property and 2) wetland restoration has increasing value both for the public and regulatory agencies. Accordingly, the following preferred alternatives were selected under the Wetland Option:

POL Area

- No further action for soil and rock
- Groundwater extraction from rock beneath the former AST-2 and feed discharge to the Landfill 26 treatment plant
- Continuing groundwater monitoring

Burn Pit

- Demolition of the concrete pad
- Soil excavation and biological treatment
- One-time collection of groundwater from excavation pit and treatment of water at the Landfill 26 treatment plant
- Backfill and cover with 3 feet of clean fill

Revetment Area

- Excavation of soil from perimeter of each aircraft parking pad with TPH detections that exceeded 100 mg/kg in the EI
- No demolition of concrete
- Soil at unpaved or deteriorated asphalt turnouts will either be excavated and treated or cleared from remediation by confirmatory sampling by the Corps of Engineers
- Backfill with 3 feet of clean fill over areas that contain 10 to 100 mg/kg TPH

Pump Station Area (OU-2)

- Excavation of soil from the area of each AST and from the stockpile area
- Soil remediation by biological treatment for TPH and other organics
- Soil remediation by biological treatment and stabilization where contaminants include metals
- Backfill and cover excavations with 3 feet of clean fill
- One-time collection of groundwater from excavation pits and treatment of water at the Landfill 26 plant

Pump Station Area Tidal Wetland (OU-2)

- Extent of contamination in tidal wetland east of the levee is larger than concluded in the EI
- Remedial action may involve excavation and treatment of sediment
- Preferred alternative to be evaluated following further investigations

FSTP

- Excavation and treatment of soil from the former sludge drying beds location
- Contaminated soil to be treated either by chemical oxidation with stabilization or soil washing (final selection of a treatment alternative will be based on results of bench scale treatability testing)
- Placement of 3 feet of clean cover fill
- Quarterly monitoring in lieu of groundwater remediation

East Levee Landfill

- No further action
- Separate action for remediating the off-site burn area near the East Levee Landfill

Aircraft Maintenance Area

- Excavation and remediation of organic contamination "hot spots" in soil at Storage Areas 2 and 4
- Placement of 3 feet of clean cover fill over areas that are unpaved or where the pavement is deteriorated asphalt (cover fill will be required for all property reuse options)
- Removal of sediment from the subsurface storm drains and treatment by thermal destruction
- Seal the storm drains to prevent infiltration of runoff
- Removal of chlorinated volatiles in the groundwater by passive collection and treatment at the Landfill 26 treatment plant

Fuel Lines

- Excavation of the fuel piping and associated contaminated soil in the immediate excavations will be accomplished as part of OU-1 under the supervision and according to the requirements of Marin County Department of Health and Human Services
- Treatment of fuel-contaminated soil by biotreatment
- Identification of excess contaminated soil for later removal and treatment during OU-2 actions

Building 442 (Parcel A2)

- No further action
- Parcel approved for transfer to GSA sale property (USAEC 1993a)
- Parcel evaluated in the EI, this AA and by the Corps of Engineers (Corps 1993)

Transformers

- Removal of transformers containing fluids with concentration greater than or equal to 50 ppb PCB
- No further action for other transformers

SECTION 1

INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

1.1.1 History and Authority

The Defense Secretary's Commission on Base Realignment and Closure has recommended that a portion of Hamilton Army Airfield (HAA) be closed. The proposed closure area includes the main runway and a variety of facilities surrounding the runway, including fuel storage and pumping facilities, buried fuel lines, aircraft maintenance and storage areas, an inactive hospital, miscellaneous buildings and parking lots, a landfill, drainage system pump stations, a former sewage treatment plant site, a burn pit, and an engine test area. A required precursor to base closure is the completion of environmental studies and restoration of areas containing toxic or hazardous contaminants.

The environmental studies associated with base closure are to be completed as part of the United States (U.S.) Department of the Army (Army) Installation Restoration Program (IRP) under the auspices of the U.S. Army Environmental Center (USAEC), formerly U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). The IRP is the Army's response program under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and was developed to identify and control migration of toxic and hazardous contamination resulting from past operations at Army facilities. As delegated by Executive Order 12580, the Army is responsible for determining response actions, consistent with the National Contingency Plan (NCP) (40 CFR 300), necessary for the abatement of contamination resulting from releases of hazardous substances. USAEC is the agency responsible for conducting preliminary assessment/site investigation (PA/SI) and remedial investigation/feasibility study (RI/FS) projects as required by CERCLA, as well as non-CERCLA environmental assessment and restoration activities, on numerous Army installations and facilities.

This Alternatives Assessment (AA) has been conducted by Engineering-Science, Inc. (ES) under contract to USAEC as part of base closure activities. Authority for performance of the AA is derived from Contract Number DAAA15-90-D-0008, Task Order 0002. The contract also specifies conduct of an Environmental Investigation (EI), which was completed during the same contract period.

1.1.2 Project Organization and Personnel

Supervision and conduct of the AA has been performed and directed by the ES Alameda staff, with equipment and personnel from other ES offices employed when necessary.

The following lists personnel who provided administrative guidance or who played major roles in the conduct of the investigations and the preparation of the AA report.

• S. G. TerMaath, Ph.D., P.E.	Project Manager
• N. E. Siler, REA	Technical Director
• J. P. Miller, P.E.	Technical Director
• F. Kintzer, R.G., CEG	EI Principal Investigator & Task Manager
• C. R. Wong, P.E., CHMM	Alternatives Assessment Principal Investigator
• S. Hailperin	Public Health Risk Assessment, Applicable, Relevant and Appropriate Requirements (ARARs)

1.1.3 Purpose and Objectives

The objective of the AA is to identify, develop, and evaluate implementable remedial alternatives. The environmental investigation (EI) was conducted by ES in two phases in 1991 and 1992, respectively, under the direction of USAEC to characterize the distribution, type and concentrations of contaminants and associated risks to public health and environment at HAA. The Final EI Report outlined the combined results of the Phase I and Phase II environmental investigations (Engineering-Science, 1993b). This AA Report serves as a companion document to the EI Report to identify appropriate remediation alternatives to achieve the cleanup levels established by the regulatory agencies.

1.1.4 Organization of Report

Section 1 summarizes background information and the nature and extent of contamination identified in the EI. Section 2 specifies the remedial action objectives and general response actions; identifies the ARARs and remedial technologies; and screens these technologies. Section 3 develops and screens remedial alternatives. Sections 4 and 5 provide detailed evaluations of screened alternatives for the property development scenario and wetland scenario, respectively. Section 6 presents the recommended remedial actions. As in the EI, the AA was conducted for each of the 10 sites at HAA. In this report, these sites will be numbered as follows:

- Site 1: Petroleum Oil Lubrication (POL) Area
- Site 2: Burn Pit
- Site 3: Revetment Area (including Engine Test Pad)

- Site 4: Pump Station
- Site 5: Former Sewage Treatment Plant
- Site 6: East Levee Landfill
- Site 7: Aircraft Maintenance Area
- Site 8: Fuel Lines
- Site 9: Building 442 Above-ground Storage Tank (AST)
- Site 10: Transformers and Oil Filled Items

There are several sites at Hamilton Army Airfield where either the full extent of contamination has not been determined, cleanup levels have not been agreed upon, or remedial action cannot be taken concurrently with the rest of Operable Unit 1. These sites have been separated into a second operable unit. Operable Unit 2 includes the Pump Station, Fuel Lines, the perimeter ditch at Aircraft Maintenance, and the tidal wetlands at the Pump Station. Additional investigations will be conducted to evaluate the extent and nature of contamination. The discussion of these sites in this Alternatives Assessment is based on information available to date.

1.2 BACKGROUND INFORMATION

1.2.1 Site Description

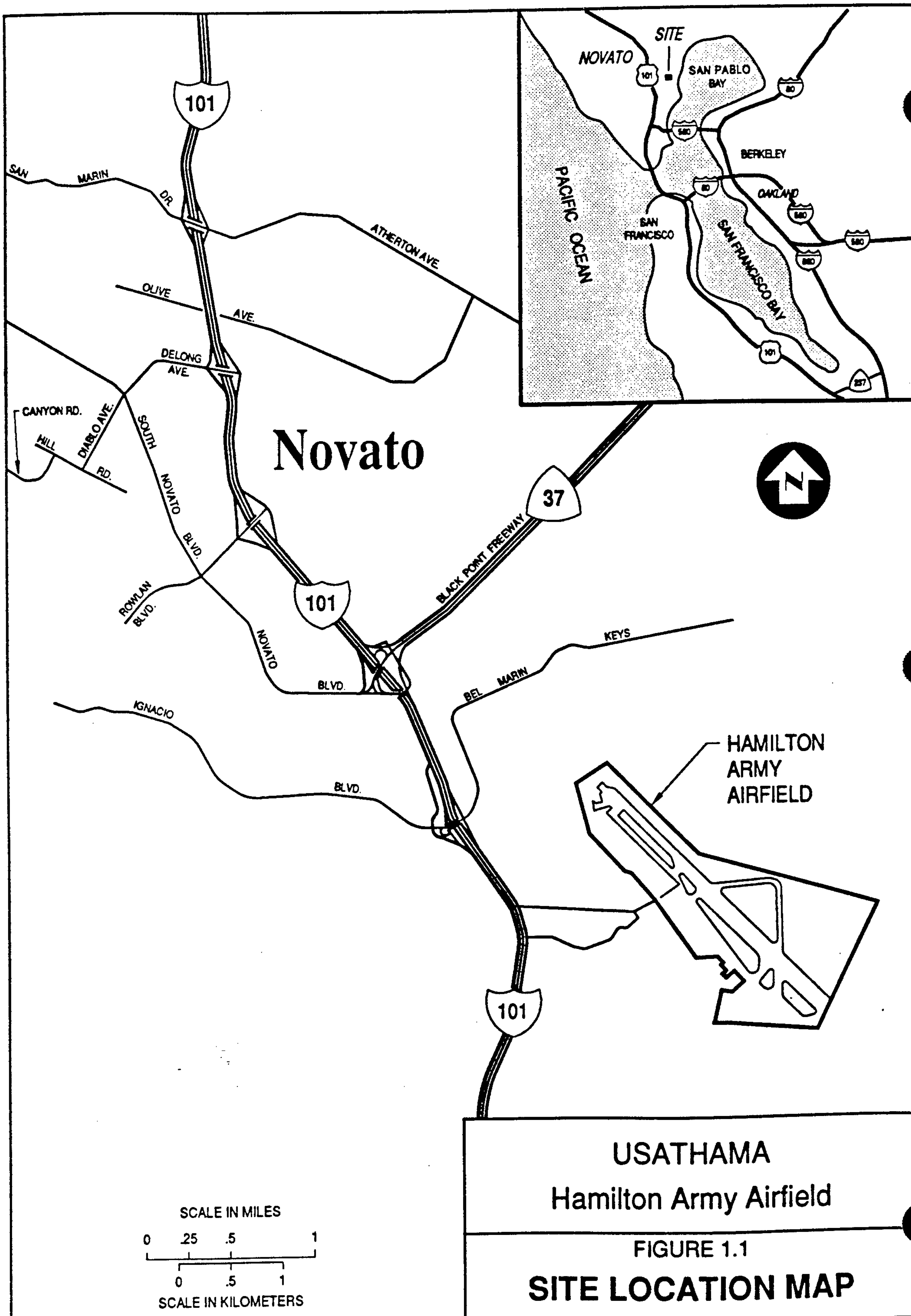
HAA is located approximately 22 miles north of San Francisco at the southern end of the City of Novato, Marin County, California (see Figure 1.1). The combined Army properties currently consists of approximately 700 acres.

The study area is enclosed within the boundaries of the property designated for closure. Figure 1.2 illustrates the boundaries of the study area, showing the 10 sites. Some of the buildings appear to have been used for offices and related uses. Other buildings were used as health care facilities; aircraft maintenance and storage activities, and a stormwater runoff control system.

Land adjacent to the site consists mainly of the remainder of what had at one time been considered part of HAA. South of the site is Navy-operated housing. Southwest of the site and surrounding the four noncontiguous parcels is the General Services Administration (GSA) sale property. North of the runway and east of the east levee is State-owned land. Bel Marin Keys, a private residential community, is located north and northwest of the runway. The area north of the runway is currently used for farming activities.

1.2.2 Background and Previous Studies

Several previous environmental studies have been conducted at HAA. Environmental Science and Engineering, Inc. briefly described waste management practices at HAA in the Installation Assessment of the Presidio of San Francisco and its subinstallations (McMaster et al., 1983). Woodward-Clyde Consultants (WCC) (1985) prepared a confirmation study for hazardous materials that addressed storage tanks, barrel storage,



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Hamilton Army Airfield

FIGURE 1.1

SITE LOCATION MAP

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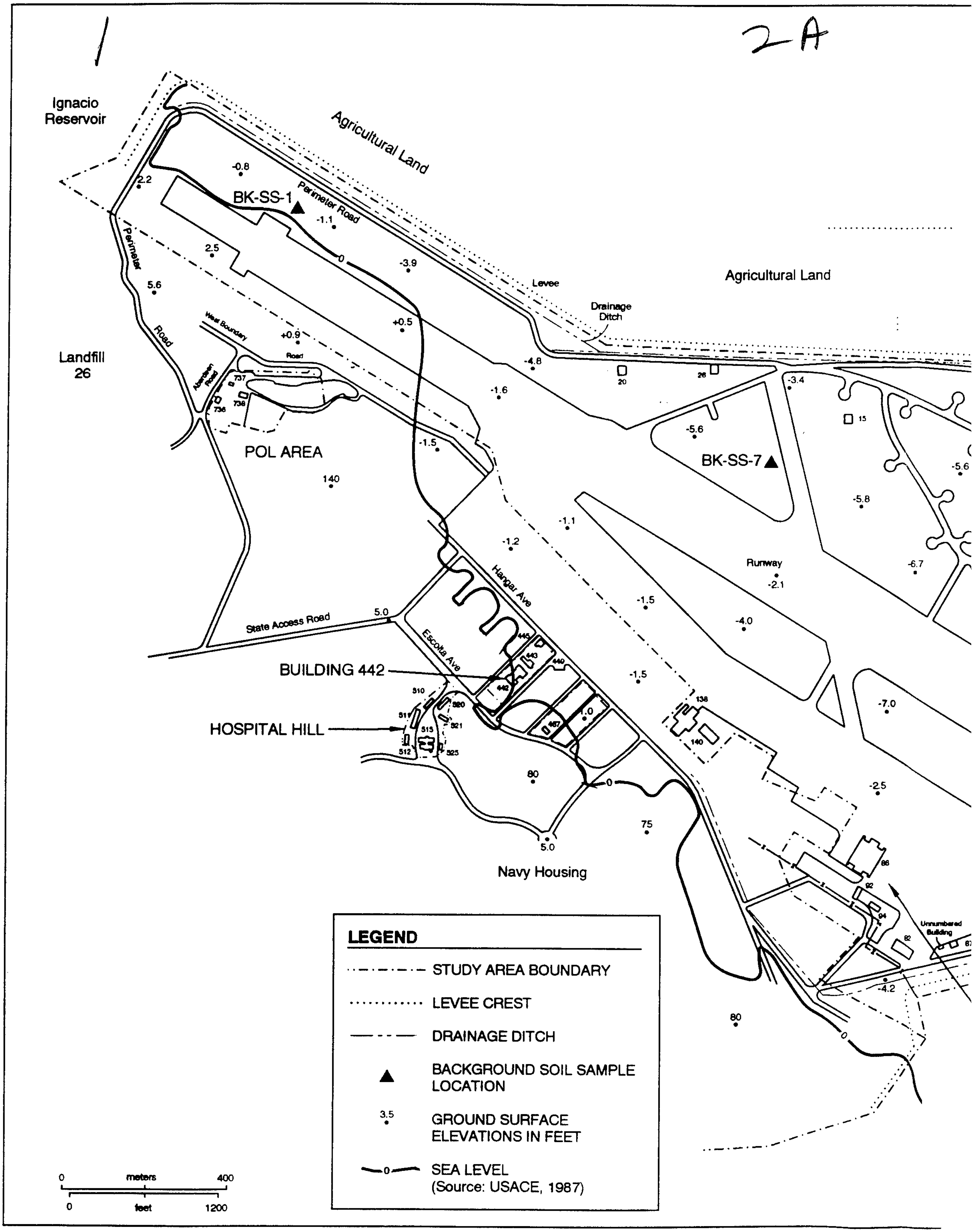

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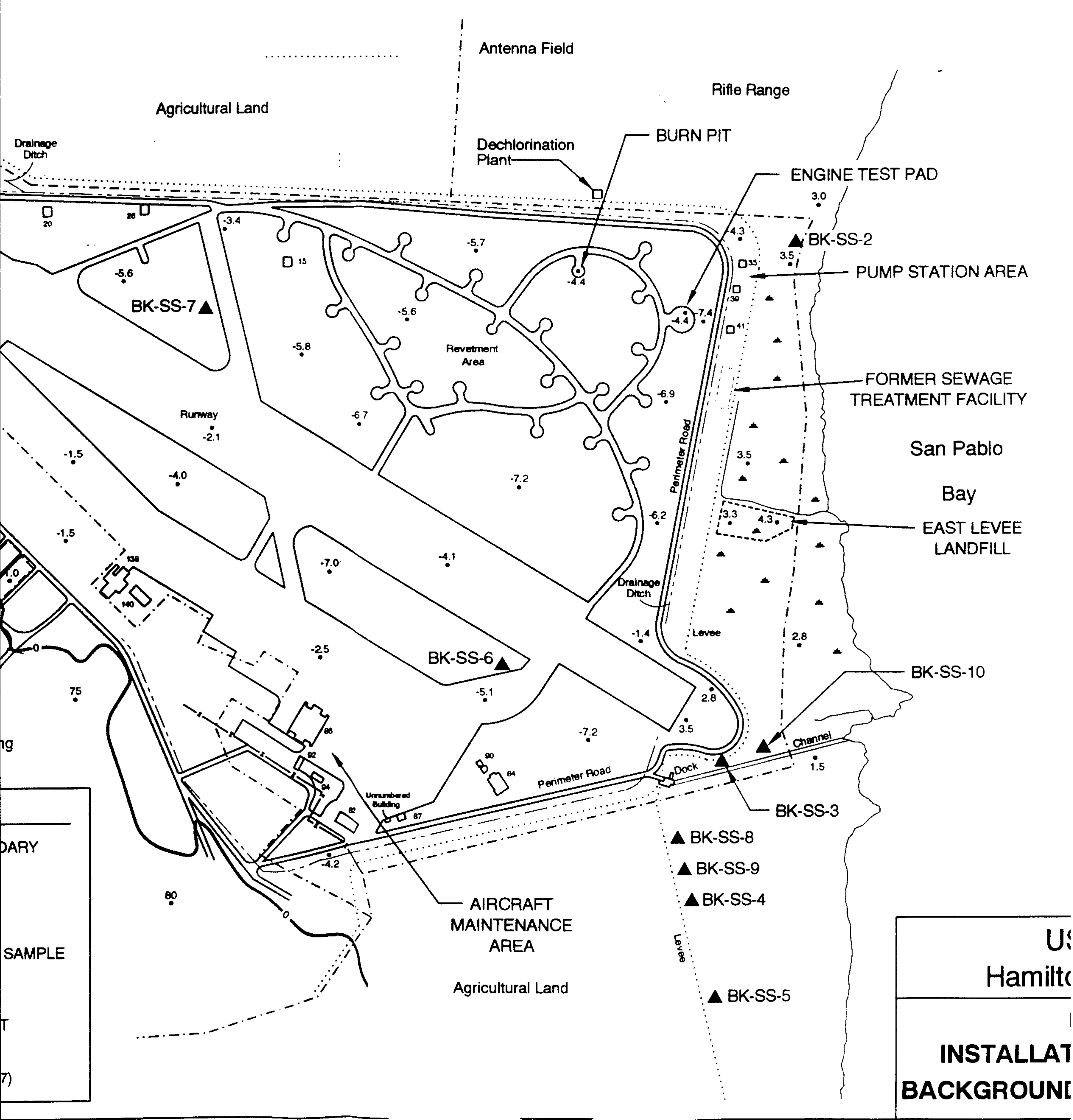

Antenna Field
Agricultural Land
Rifle Range
Drainage Ditch
Dechlorination Plant
BURN PIT
ENGINE TEST PAD
BK-SS-2
PUMP STATION AREA
BK-SS-7
Revetment Area
FORMER SEWAGE TREATMENT FACILITY
San Pablo Bay
Runway
Perimeter Road
EAST LEVEE LANDFILL
Drainage Ditch
Levee
BK-SS-6
BK-SS-10
Channel
Dock
Perimeter Road
Unnumbered Building
BK-SS-3
BK-SS-8
BK-SS-9
BK-SS-4
AIRCRAFT MAINTENANCE AREA
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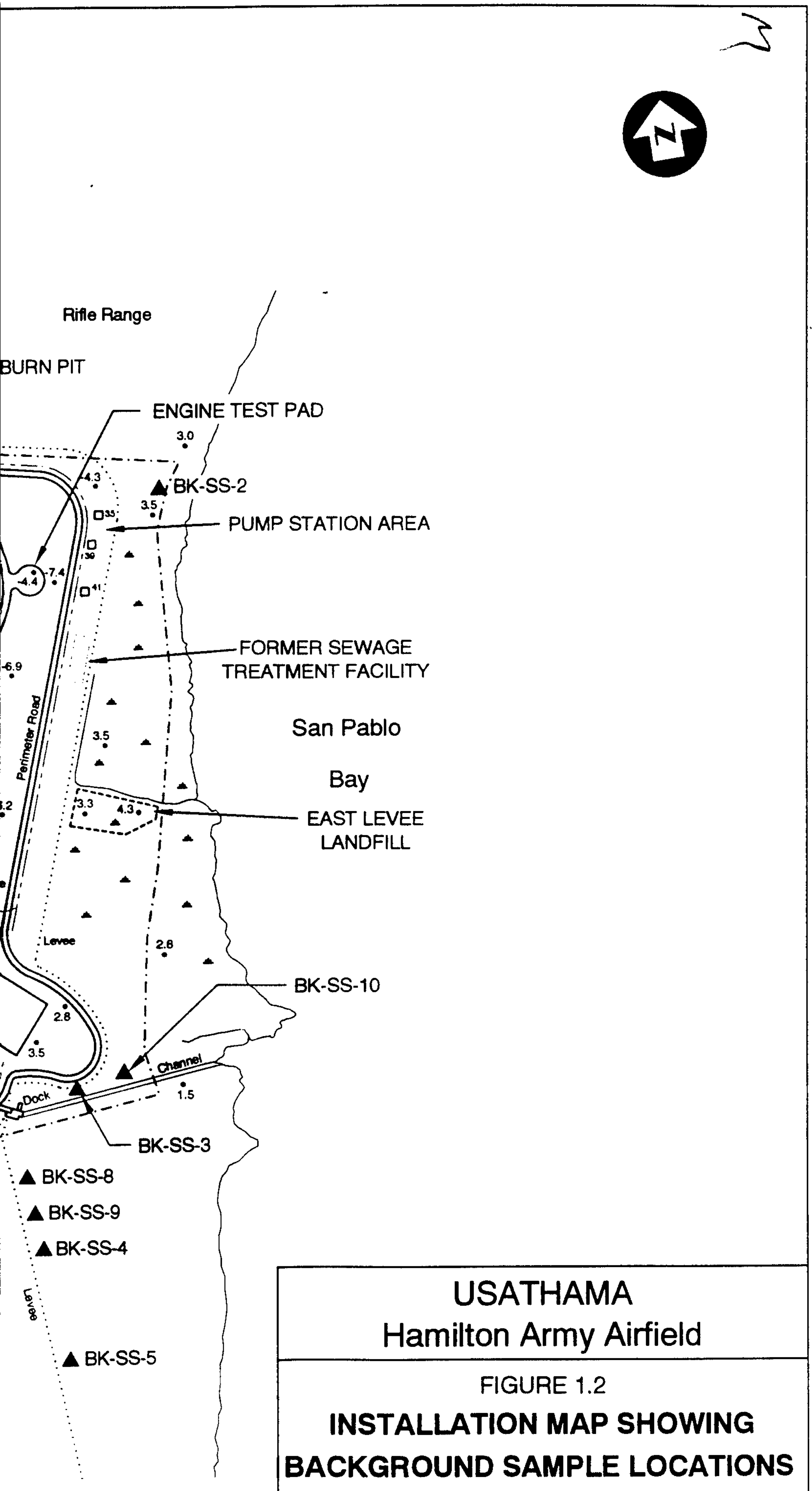

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Hamilton Army Airfield

FIGURE 1.2
INSTALLATION MAP SHOWING BACKGROUND SAMPLE LOCATIONS

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waste fuel areas, concrete sumps and POL facilities on GSA Sale Property. That study also covered the non-GSA sale area POL facility described in the present study. In 1987, WCC completed a remedial investigation of known and suspected landfills located on GSA Sale property (WCC 1987b), and a confirmation study for hazardous waste on army property outside the GSA Sale Property (WCC 1987a), that includes most of the areas described in the present study. An Enhanced Preliminary Assessment of army property at HAA was conducted by Roy F. Weston, Inc. (1990), and is based on a site visit, reviews of relevant literature and records, and data derived from exploratory work performed by WCC (1985, 1987a, 1987b). The United States Army Corps of Engineers (Corps 1990) prepared an Environmental Assessment of the entire base closure area, which included a review of future land use options and a discussion of the impacts of hazardous wastes at the property. Based on results of the previous studies, E.C. Jordan developed a Technical Plan and Sampling Design Plan (Jordan 1990a, 1990b). Engineering-Science conducted Phase I of the EI based on these plans. In 1992 Phase II of the EI was conducted to further characterize the extent of contamination. The findings were presented in the Final EI Report (Engineering-Science 1993).

The following three items of investigation were part of the original scope of work but were deleted by a contract modification: 1) Radon was not evaluated in the EI. A previous radon screening study was conducted in housing units near the base closure property and did not indicate a need for further evaluation of radon levels; 2) A former polychlorinated biphenyl (PCB) drum site was not evaluated. The drum and associated contaminated materials were removed from the site in 1990 and soil sampling at the drum site indicated no PCB contamination; and 3) The former radiological disposal site was not evaluated since remediation had been done in 1988 as part of a Corps of Engineers contract. Further information is given in the Final EI report, Section 1.4 and in Weston (1990).

1.2.3 Nature and Extent of Contamination

Results of the EI indicated that media of concern are soil (soils and sediments) and groundwater. The contaminants of concern are petroleum hydrocarbons, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, PCBs, cyanide, pesticides, herbicides and other compounds such as salts. A summary of soil and groundwater contaminant types detected at each site is presented in this subsection. A discussion of the fate and transport of these contaminants is presented in Section 1.2.4. Public health and environmental risk assessments were performed and the results are summarized in Section 1.2.5 and discussed in detail in the EI (Engineering-Science 1993).

Complete analytical tables of chemicals that were detected at concentrations above their certified reporting limits (CRLs) are contained in Appendix A and a more detailed discussion of the contaminant distribution is presented in Section 4 (Development Option) and Section 6 (Wetland Option). The CRLs are laboratory-determined method detection limits for the specific analytes and test methods.

Additional environmental samples will be collected as part of the remedial design and remedial action phases. This is discussed in more detail in Section 1.3.

1.2.3.1 Site Areas of Concern - Soils

Table 1.1 presents a summary of contaminant types detected for each site. The following subsections summarize the extent of soil contamination at each site. Appendix A provides contaminant concentrations found at each site (Engineering-Science 1993).

1.2.3.1.1 Extent of Soil Contamination (Site 1 - POL Area). The POL Area consists of approximately 7.5 acres of land enclosed by a cyclone fence. There are three vacant buildings which have been used for the temporary storage of waste oil prior to removal by a refuse company (Jordan 1990a). At the time of this study, the western portion of the POL area was paved with asphalt, while the remainder was underlain by either bedrock or poorly consolidated fill.

The POL Area previously contained 21 underground storage tanks (USTs) and several ASTs used to store aircraft fuel. All of the USTs and one AST were removed in 1986 by IT Corporation as part of the POL Area remediation. In 1990, contaminated soil was removed and replaced with clean fill under the direction of Corps of Engineers, Sacramento District.

EI results indicated the recent remedial excavation by the Corps of Engineers, has been successful in removing fuel-contaminated soil and rock. An estimated 24,000 cubic yards were excavated and stockpiled for treatment on GSA Sale Property about 500 feet to the north of the POL area. However, residual non-leaded fuel contamination remains both in the groundwater and unsaturated rock on the ridge beneath the former location of AST-2.

Soil boring analytical data confirmed elevated total petroleum hydrocarbon (TPH) concentrations in the rock along the alignment of the recently removed fuel supply line that formerly led from AST-2 to the tank farm. Approximately 15,000 cubic yards of residual-contaminated (above 100 mg/kg TPH) rock are estimated to remain in the POL (Section 2, Table 2.8a). This contaminated rock accounts for about 75 percent by volume of all soil/rock contamination estimated to be present at the sites.

Figure 1.3 shows the estimated locations of area of concern. Also shown on Figure 1.3 are three soil boring samples which had TPH concentrations exceeding 100 mg/kg (503 mg/kg, 401 mg/kg and 113 mg/kg at monitoring well borings 104, 115 and 101 respectively). Low concentrations of VOCs and SVOCs (1 to 3 mg/kg) were also detected in the soil samples. A summary of subsurface soil contamination is provided in Appendix A.

Lead concentrations in drill cutting samples ranged from 5.9 to 15.2 mg/kg, well within background levels.

1.2.3.1.2 Extent of Soil Contamination (Site 2 - Burn Pit). The Burn Pit Area has three hydrogeologic units. The concrete pad (1 foot to 1.5 feet thick) forms a semi-impermeable cap traversed by two orthogonal expansion joints which form open conduits to underlying materials. A zero- to three-foot thick layer of coarse fill consisting of clayey, silty, sand and gravel underlies the pad, which is underlain by natural earth materials consisting entirely of moist, silty clay (Quaternary Bay Mud), which was

TABLE 1.1

TYPES OF CONTAMINANTS DETECTED
HAMILTON ARMY AIRFIELD

Site	Media	Contaminants Detected
Site 1 POL Area	Soil	TPH, VOCs, SVOCs, lead
	Groundwater	TPH, VOCs, SVOCs, lead
Site 2 Burn Pit		
• Beneath Pad	Soil	TPH, VOCs, SVOCs, lead
• Perimeter of Pad	Soil	TPH, toluene, SVOCs, lead
• Beneath and Perimeter of Pad	Groundwater	TPH, VOCs, lead
Site 3 Revetment		
• Revetment Pads	Soil	TPH, SVOCs, lead
• Engine Test Pad	Soil	TPH, toluene, SVOCs, lead
	Groundwater	metals*, cyanide*
Site 4 Pump Station		
• AST Site	Soil	TPH, VOCs, SVOCs, lead
• Stockpile	Soil	TPH, VOCs, SVOCs, lead
• Sediments	Sediments	TPH, SVOCs, metals, lead
	Groundwater	VOCs*, metals*, cyanide*
Site 5 Former Sewage Treatment Plant	Soil	TPH, toluene, SVOCs, metals, cyanide, pesticides
	Sediment	metals, cyanide
	Groundwater	VOCs, SVOCs, metals
Site 6 East Levee Landfill	Soil	SVOCs, metals
	Groundwater	VOCs*, metals*
Site 7 Aircraft Maintenance and Storage Area	Soil	TPH, VOCs, metals, cyanide
	Sediment	TPH, VOCs, SVOCs, metals, lead, cyanide
	Groundwater	VOCs, SVOCs, metals
Site 8 Fuel Lines	Soil	TPH
Site 9 Building 442	Soil	lead
Site 10 Transformers and Oil-Filled Items	--	Polychlorinated Biphenyl (PCB)

* Concentrations are below MCLs.

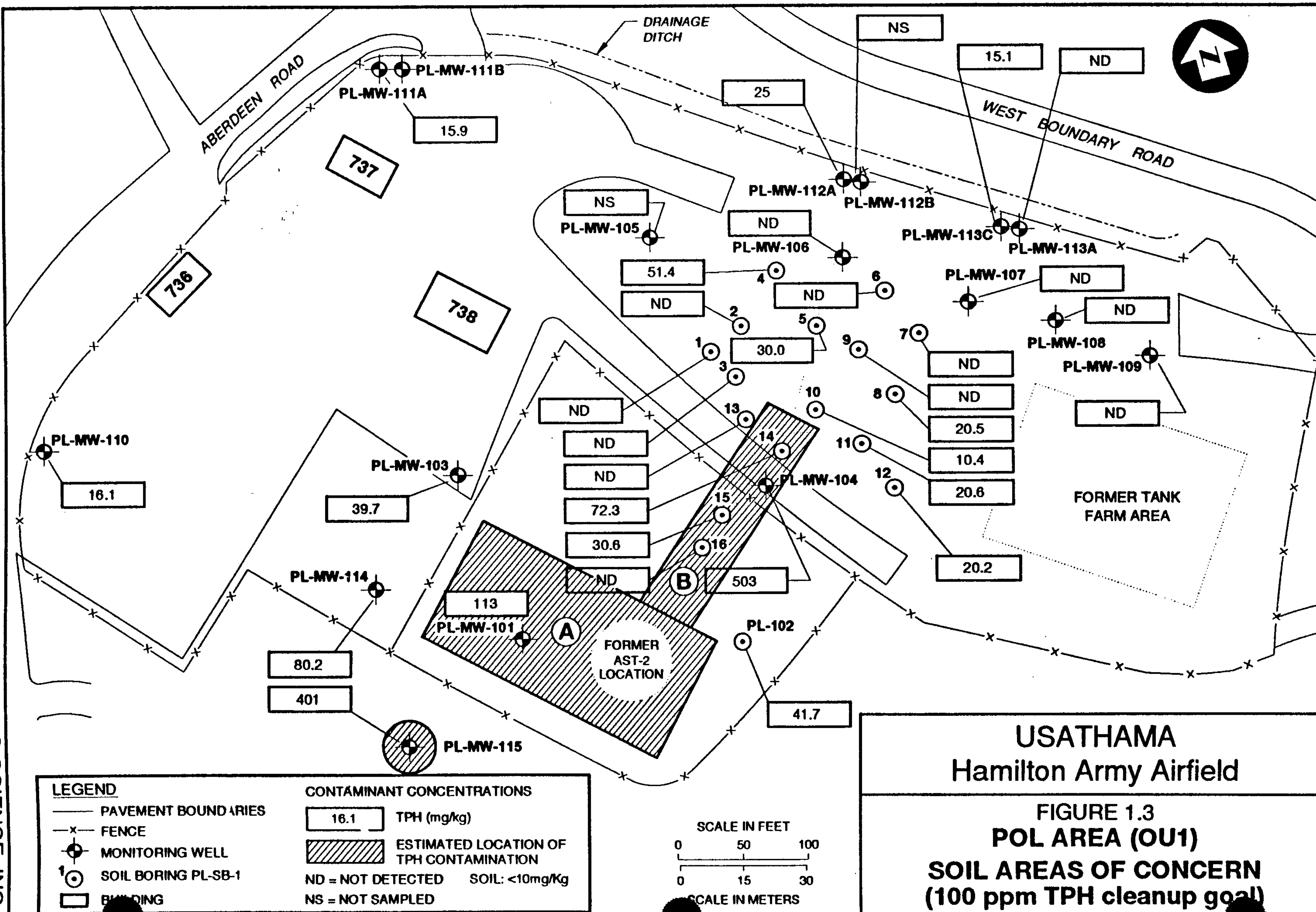

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FIGURE 1.3
POL AREA (OU1)
SOIL AREAS OF CONCERN
(100 ppm TPH cleanup goal)

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encountered to total depth of approximately 15 feet in all wells. The Bay Mud unit is best classified as an unconfined aquitard. The water table lies within the Bay Mud.

Tables A-2.1a and A-2.1b of Appendix A present summaries of surface soil contamination and subsurface soil contamination for the Burn Pit Area. Figure 1.4a shows the estimated locations of areas of concern, and Figure 1.4b shows cross sections of the Burn Pit annotated with TPH contaminant levels.

Perimeter of Pad. Surficial soils around the pad were found to be locally elevated in TPH concentration but generally lower than the concentrations found beneath the center of the pad. TPH was detected as high as 346 mg/kg at BP-SS-5 along the perimeter of the pad. VOC and SVOC were detected but concentrations were generally low (8 mg/kg) to non-detectable. Lead was also detected just above 50 mg/kg.

Subsurface soil around the pad also had varying levels of TPH contamination. The maximum TPH concentration detected was 190 mg/kg at BP-MW-103. VOC and lead were also detected at very low (2 mg/kg) concentrations.

Beneath Pad. The larger magnitude of contamination exists under the pad rather than around the perimeter. Apparently the expansion joints act as vertical conduits allowing contaminants to migrate into the subsurface. Principle subsurface soil contamination found was localized residual fuel hydrocarbon compounds (TPH). Figure 1.4b shows that in one boring at the center of the pad TPH was found at 1,920 mg/kg at 2 feet in depth. The concentration of TPH uniformly decreases with depth to 17.3 mg/kg at 7 feet in depth. The estimated area of concern beneath the pad is approximately 3,400 cubic yards.

Elevated VOC and SVOC concentrations were also present in the soil beneath the center of the pad. Total BTEX was 3.0 mg/kg, total VOCs were 405 mg/kg and total SVOCs were 148 mg/kg.

1.2.3.1.3 Extent of Soil Contamination (Site 3 - Revetment Area). The Revetment Area consists of a broad, flat region that lies just inside the levee system. This area is transected by taxiways, alongside which circular concrete pads historically used as aircraft staging areas. Each concrete pad is approximately 120 feet in diameter, with the exception of the Engine Test Pad, which is approximately 200 feet in diameter. The concrete pads and taxiways form a network of impermeable caps, although these are transversed by expansion joints which form open conduits to underlying materials. A zero to three foot thick layer of coarse fill underlies the concrete. The two artificial layers are underlain by natural earth materials consisting of moist, essentially homogeneous, silty clay. The clay probably extends to significant depth [at least 25 feet below ground surface (bgs)] throughout much if not all of the Revetment Area. The entire Revetment Area lies approximately 4 feet below sea-level, and is protected from inundation by the HAA levee system and associated storm drain and pumping system. Estimated soil areas of concern for TPH contamination at the Revetment Area are illustrated in Figure 1.5. Summaries of surface soil contamination at the Revetment Pad Area and Engine Test Pad are included in Appendix A.

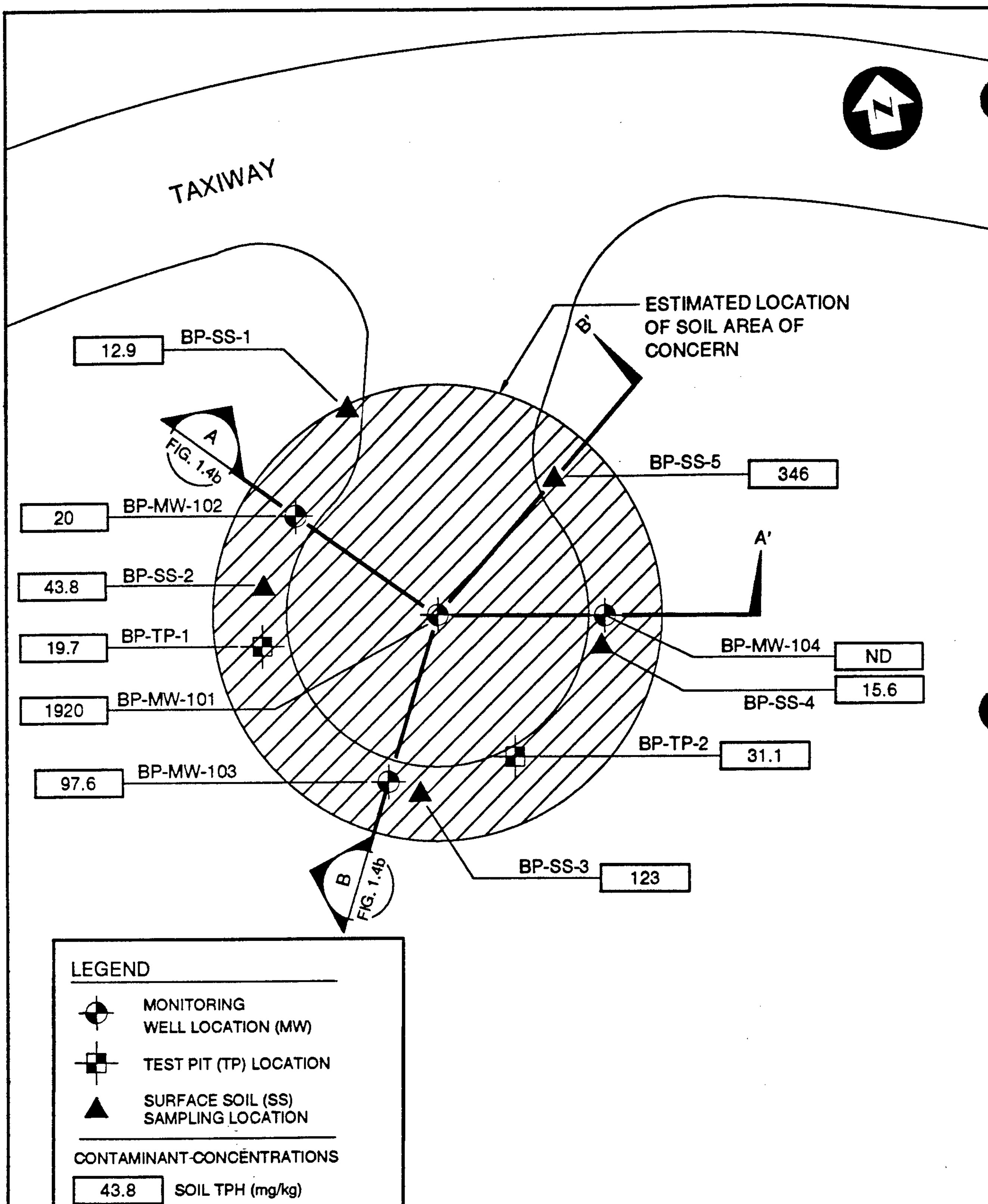

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FIGURE 1.4a
BURN PIT (OU1)
SOIL AREA OF CONCERN
(10ppm TPH cleanup goal)

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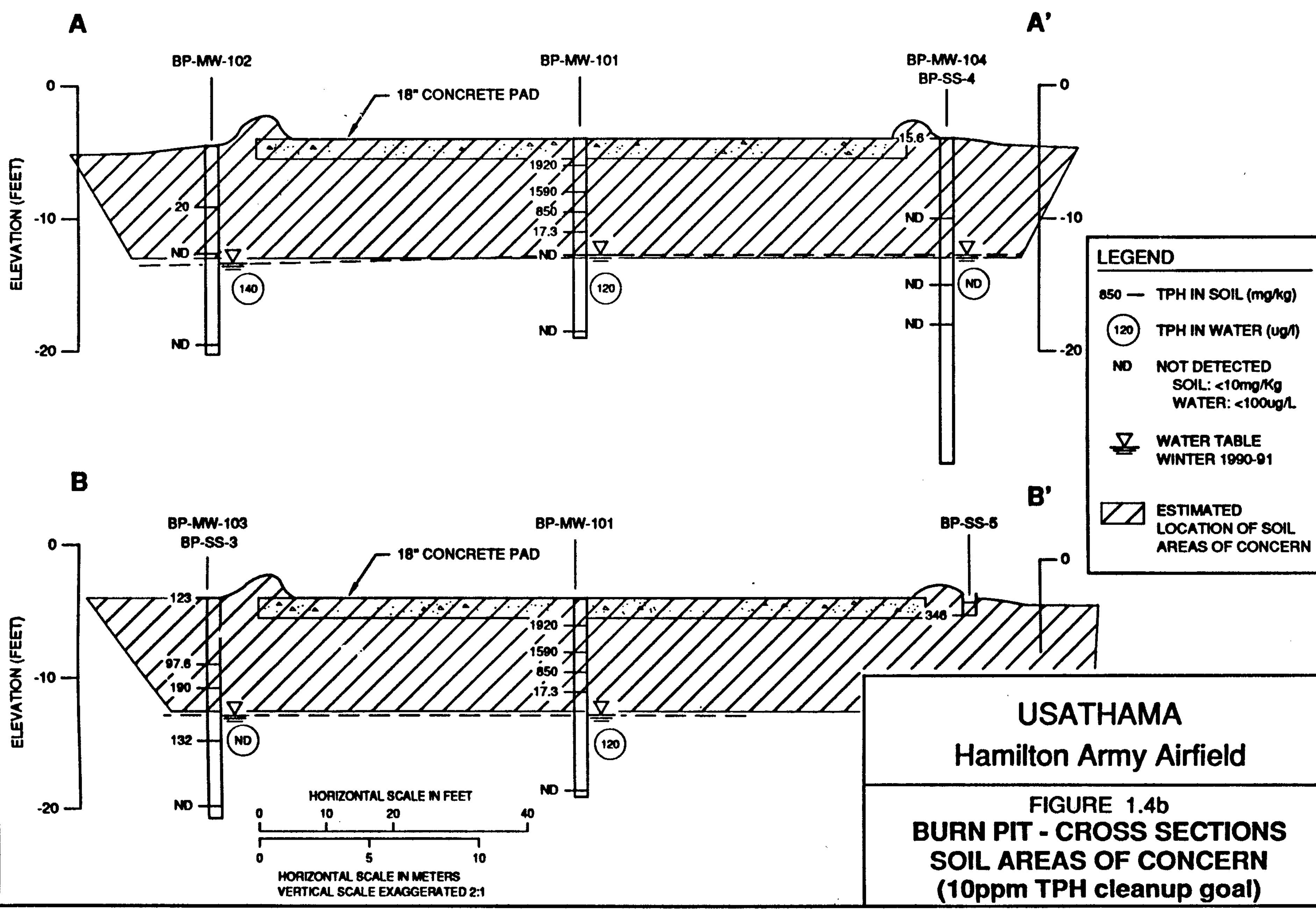

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FIGURE 1.4b
BURN PIT - CROSS SECTIONS
SOIL AREAS OF CONCERN
(10ppm TPH cleanup goal)

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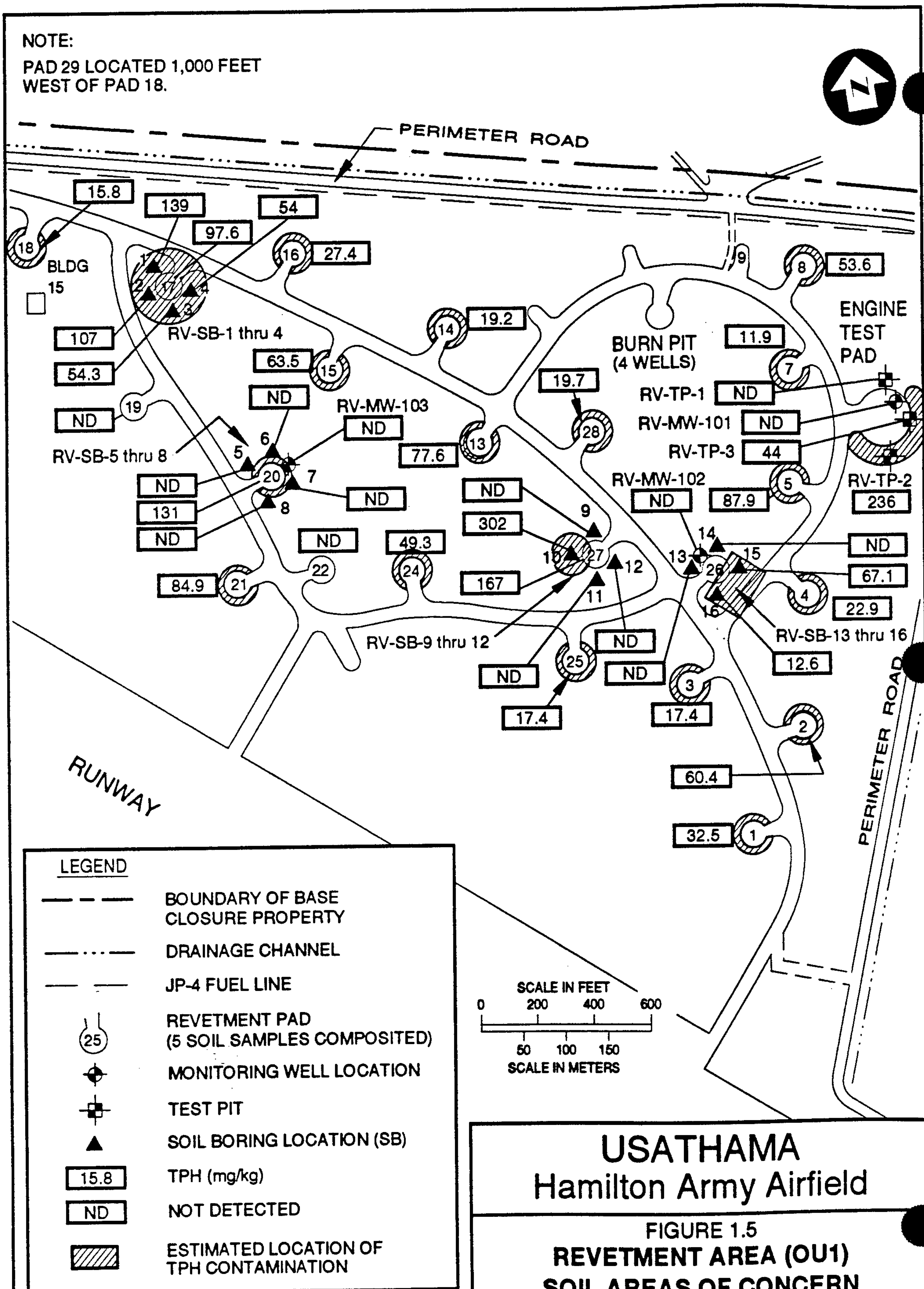

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FIGURE 1.5
REVETMENT AREA (OU1)
SOIL AREAS OF CONCERN
(10ppm TPH cleanup goal)

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Engine Test Pad. Subsurface exploration was conducted at the Engine Test Pad. Maximum concentration of TPH detected was 236 mg/kg in a surface sample. Low concentrations of SVOCs (0.8 mg/kg) were detected as deep as 6 feet.

Revetment Pads. Analytical results of surficial soils samples and 16 soil boring samples from Pads 17, 20, 26 and 27 collected around the periphery of the concrete pads at each of the staging pad indicate sporadic TPH contamination above 10 ppm. Specifically, pads 1, 2, 3, 4, 5, 8, 13, 14, 15, 16, 17, 18, 20 21, 24, 25, 26, 27 and 28 had TPH contamination greater than 10 mg/kg; BTEX was not detected in any of the boring samples.

Several SVOCs were detected in surface samples at pads 1, 7, 15, 20 and 27 but concentrations were generally less than 1 mg/kg. The maximum concentration of SVOCs detected was approximately 36 mg/kg at pad 20.

Lead concentrations detected in the soils were generally near background levels. The maximum concentration of lead detected was 44 mg/kg at pads 13 and 20.

Five revetment turnouts are not paved with concrete and were identified in the draft HAA CERFA report (The Earth Technology Corp., 1994). Although soil at these "pads" (9, 11, 12, 23, 29) was not sampled, it is possible that they have been contaminated. Pad 29 is located south of Building 26, west of the Revetment Area.

1.2.3.1.4 Extent of Soil Contamination (Site 4 - Pump Station). The Pump Station includes several buildings which contain three stormwater pumps used to remove storm runoff from HAA into San Pablo Bay. There are three ASTs and an inactive UST.

Subsurface soil consists of clayey silt with traces of gravel at shallow depths underlain by silty clay (Quaternary Bay Mud).

Soil contamination appears to be surficial and localized at tanks and soil stockpile. Estimated locations of areas of concern for the Pump Station are shown in Figure 1.6. Appendix A present summaries of organic and inorganic contaminants detected at the Pump Station Area.

AST Sites. The highest concentrations of TPH were found in surface soil samples near the site of AST-6 (332,000 mg/kg), AST-5 (166,000 mg/kg) and AST-7 (11,100 mg/kg). Elevated levels of SVOCs were also detected near the sites of AST-5 and AST-6. Lead was detected near AST-6 as high as 410 mg/kg. Pesticides 2,4,6-Trichlorophenol (11.2 mg/kg) and beta-Benzene hexachloride (46.1 mg/kg) were detected near AST-6 and AST-5 respectively.

Stockpile. Soil stockpile on the north side of Building 41 appears to be contaminated only with TPH. Surface soil TPH concentration ranged from 779 to 1,570 mg/kg. The soil stockpile reportedly came from partial cleanup of the AST-7 area which is next to Building 40 (Jordan 1990 and verbal communication with base personnel). An Underground Storage Tank (UST) and an AST (both not numbered) are located next to the soil stockpile. Soil samples were not collected near either the UST or AST. The

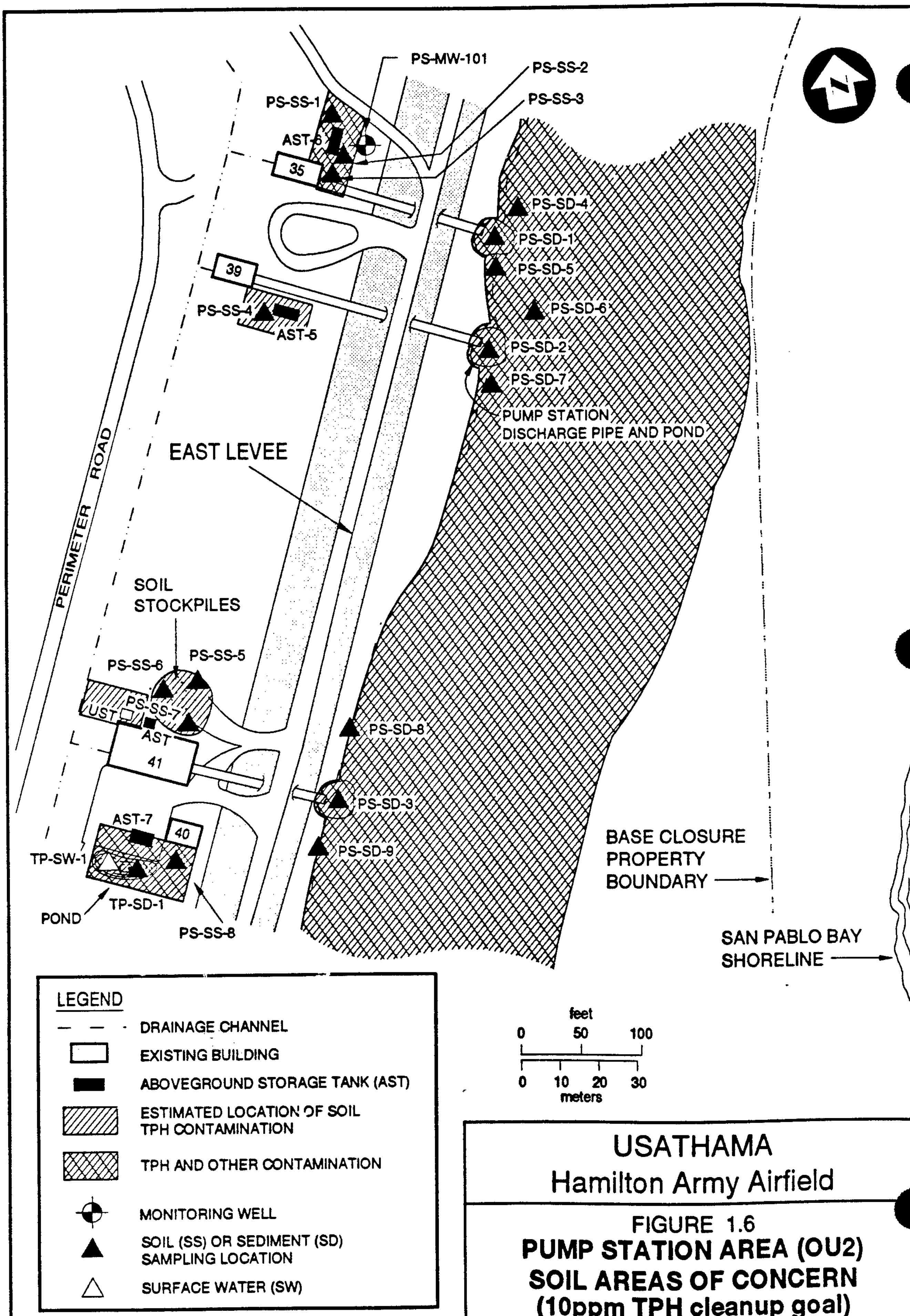

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FIGURE 1.6
PUMP STATION AREA (OU2)
SOIL AREAS OF CONCERN
(10ppm TPH cleanup goal)

REV.4 C335-21.DWG 05/04/94

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condition of the UST is unknown; a fill pipe was observed as well as a pipeline that apparently leads from the tank and crosses the perimeter ditch. However, it is assumed that TPH contamination is present.

Sediments. Sediments from the Pump Station discharge pools were found to contain TPH concentrations above 100 mg/kg and as high as 2690 mg/kg. Elevated levels of metals were also found. Pesticides DDT (0.25 mg/kg) and DDD (3.03 mg/kg) were detected in three sediment samples.

1.2.3.1.5 Extent of Soil Contamination (Site 5 - Former Sewage Treatment Plant). The Former Sewage Treatment Plant provided primary and secondary sewage treatment operations until 1986. Between 1986 and 1987, all the buildings associated with the plant were demolished; sludge drying beds and USTs and ASTs were removed.

The overall geologic setting of the Treatment Plant area is similar to the Pump Station Area. Artificial materials used in the construction of the East Levee have been emplaced over native materials consisting of silty clay (Quaternary Bay Mud) which extend to significant depth [at least 25 feet below ground surface (bgs)].

Elevated levels of TPH were detected in the drying beds. The maximum concentration of TPH (2,600 mg/kg) was detected at TP-SS-8. Only low levels of SVOCs were detected in the soils and sediments in the Former Sewage Treatment Plant (FSTP) area. Metals were detected in the soils and sediments, but at low concentrations (approximately background). Soil samples from the sludge drying beds area contained significant levels of pesticide (1.48 mg/kg DDD) and PCB (1.2 mg/kg PCB) and minor levels of SVOC contamination (1.2 mg/kg). Metals concentrations are also somewhat elevated at the levels that existed around the drying beds before their removal. No confirmatory post-cleanup soil analysis are known to have been done. A map showing estimated locations of soil areas of concern at Former Sewage Treatment Plant area is shown in Figure 1.7. Summaries of organic and inorganic contamination detected at the Former Sewage Treatment Plant area are provided in Appendix A.

1.2.3.1.6 Extent of Soil Contamination (Site 6 - East Levee Landfill). The East Levee Landfill consists of a 2 to 6 foot thick layer of construction debris overlain by a 0 to 2 foot thick cap primarily composed of sandy clay. The landfill materials have been emplaced over native materials consisting of silty clay (Quaternary Bay Mud). Figure 1.8 is a site map showing the estimated soil areas of concern at the East Levee Landfill Area. Appendix A shows a summary of subsurface soil contamination detected at the East Levee Landfill Area.

Extensive trenching in 1987 found low concentrations of TPH, VOCs and SVOCs, and some metals in shallow soils. The EI conducted found no significant soil contamination. Based on the decrease in contaminant concentrations, and tidal observations, it appears that contamination deposited in the area is likely to be confined or has been removed by frequent tidal inundation.

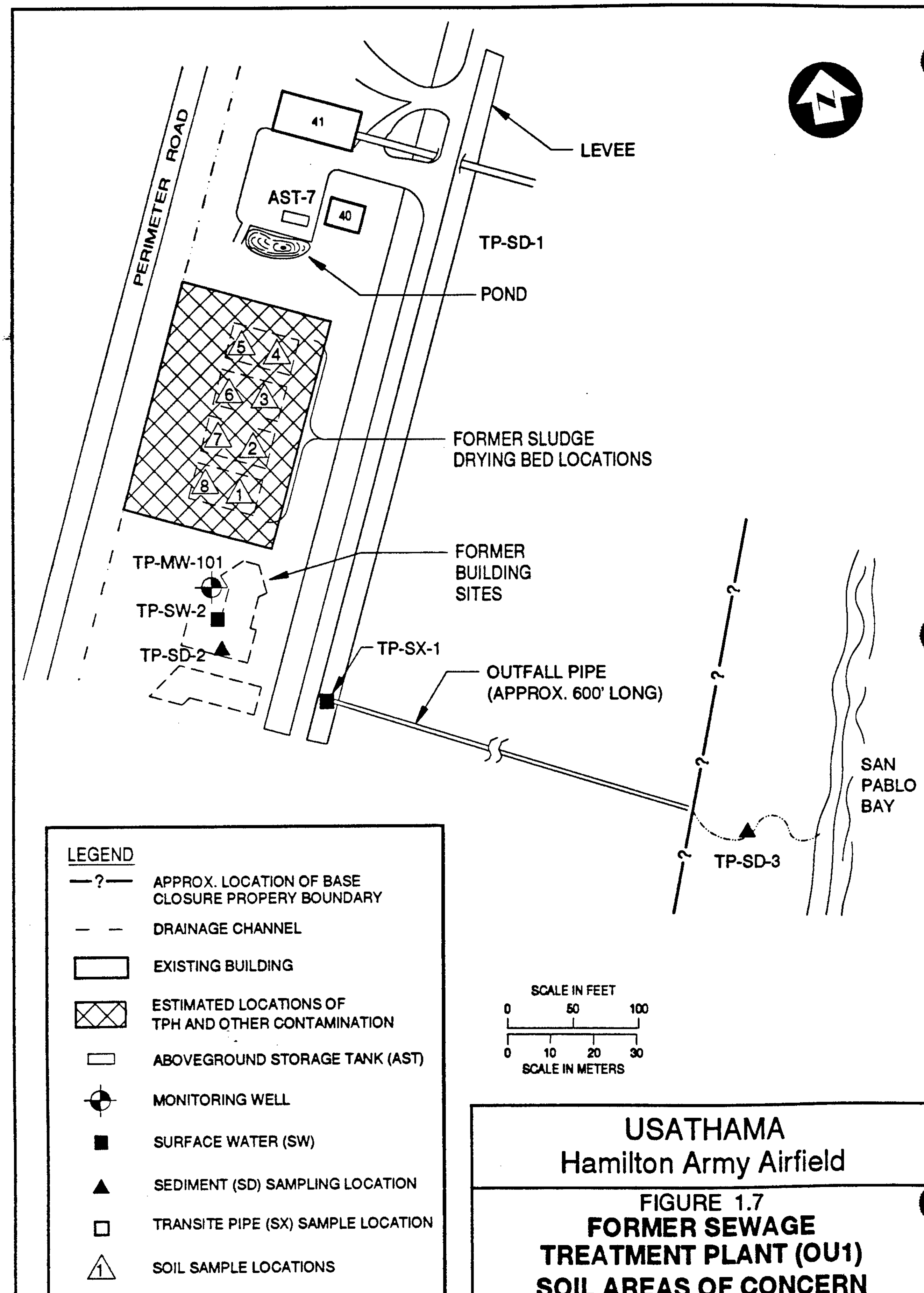

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FIGURE 1.7
FORMER SEWAGE TREATMENT PLANT (OU1)
SOIL AREAS OF CONCERN
(10ppm TPH cleanup goal)

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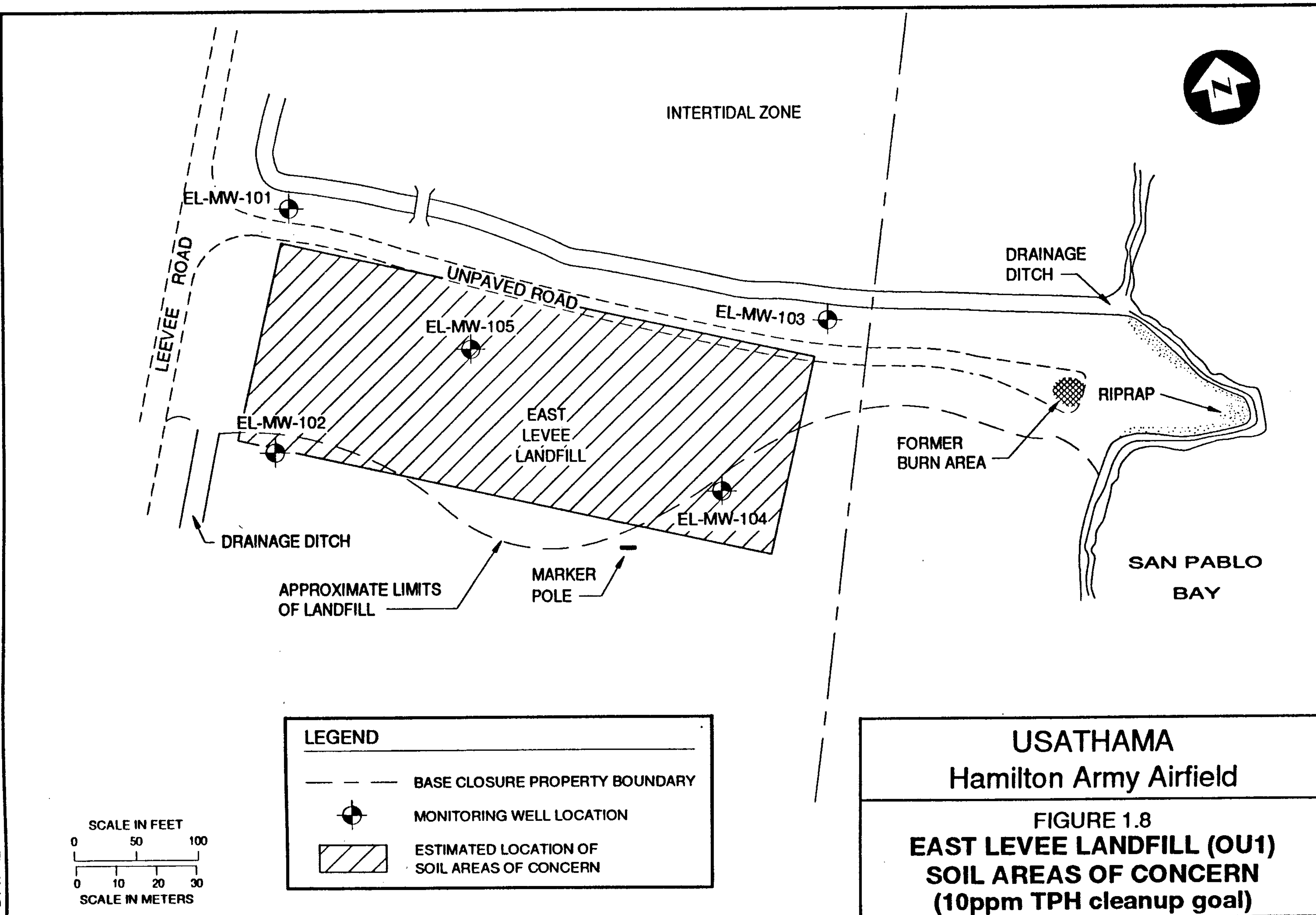

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FIGURE 1.8
EAST LEVEE LANDFILL (OU1)
SOIL AREAS OF CONCERN
(10ppm TPH cleanup goal)

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1.2.3.1.7 Extent of Soil Contamination (Site 7 - Aircraft Maintenance and Storage). Building 86 is the last hangar on base still being used for the maintenance of aircraft at HAA. Waste materials from Building 86 activities formerly were taken to Storage Area 2 to await pickup for disposal.

Three hydrogeologic units exist at the Aircraft Maintenance and Storage Area: pavement, clayey gravel fill, and Bay Mud. The concrete and asphalt surfaces form relatively impermeable caps. The clayey gravel fill material is 3 to 4 feet thick throughout the area and much more permeable than the underlying clay-rich Bay Mud. The groundwater gradient indicates that subsurface flow is southeastward toward the perimeter ditch. Figure 1.9a and 1.9b are site maps showing the estimated sediment areas of concern for TPH and non-TPH contaminants, respectively, at the Aircraft Maintenance Area. Figure 1.9c is a detailed map of TPH concentrations in soils at Storage Areas 2 and 3 and Figure 1.9d is a detailed map of Storage Area 4. Appendix A presents summaries of subsurface and sediment contamination detected at the Aircraft Maintenance Area.

Drain sediment samples contained TPH in the range of 1,200 to 2,400 mg/kg. The sediments are contained in concrete storm drain vaults and also in the perimeter ditch. Storm drain sediment contamination originated from runoff carrying contaminants from the maintenance areas. It is possible that contaminants have infiltrated through cracks that may be present in the storm drain system. The subsurface soil below the storm drain system was not sampled. Figures 1.9a and 1.9b show locations where elevated levels of metals and organics were found in the storm drain vaults.

Shallow subsurface soils near Storage Area 2 were found to contain elevated concentrations of TPH as high as 4,650 mg/kg (see Figure 1.9c). TPH contaminant concentrations decreased to around 100 mg/kg at a depth of 2.5 feet. VOCs were relatively low (less than 1 mg/kg) with the exception of 6,700 mg/kg of TICs (tentatively identified compounds) reported in Test Pit 1, AM-TP.1.

Shallow subsurface soils near Storage Area 4 were found to contain elevated concentrations of TPH as high as 1,060 mg/kg (see Figure 1.9d).

1.2.3.1.8 Extent of Soil Contamination (Site 8 - Fuel Lines). Two eight inch and one six inch fuel lines have been used to transport JP-4 and other fuels to various locations on site. Figure 1.10 shows the location of estimated areas of concern at the sampling locations.

The southeastern end of the 6-inch fuel line was found to have TPH contamination exceeding 10 mg/kg at several locations. The highest TPH concentration found was 360 mg/kg at soil sample location JP-SS-10. The contaminated area appears to be 20 feet in diameter but it extends beneath the taxiway for an unknown distance. This 2-foot thick lens of fuel contaminated soil was found at a depth of 2 feet.

1.2.3.1.9 Extent of Soil Contamination (Site 9 - Building 442 AST). Building 442 is currently inactive, but AST-11 was once used to store diesel fuel. In the past, fuel stains have been observed in the utility trench adjacent to the tank. However, shallow

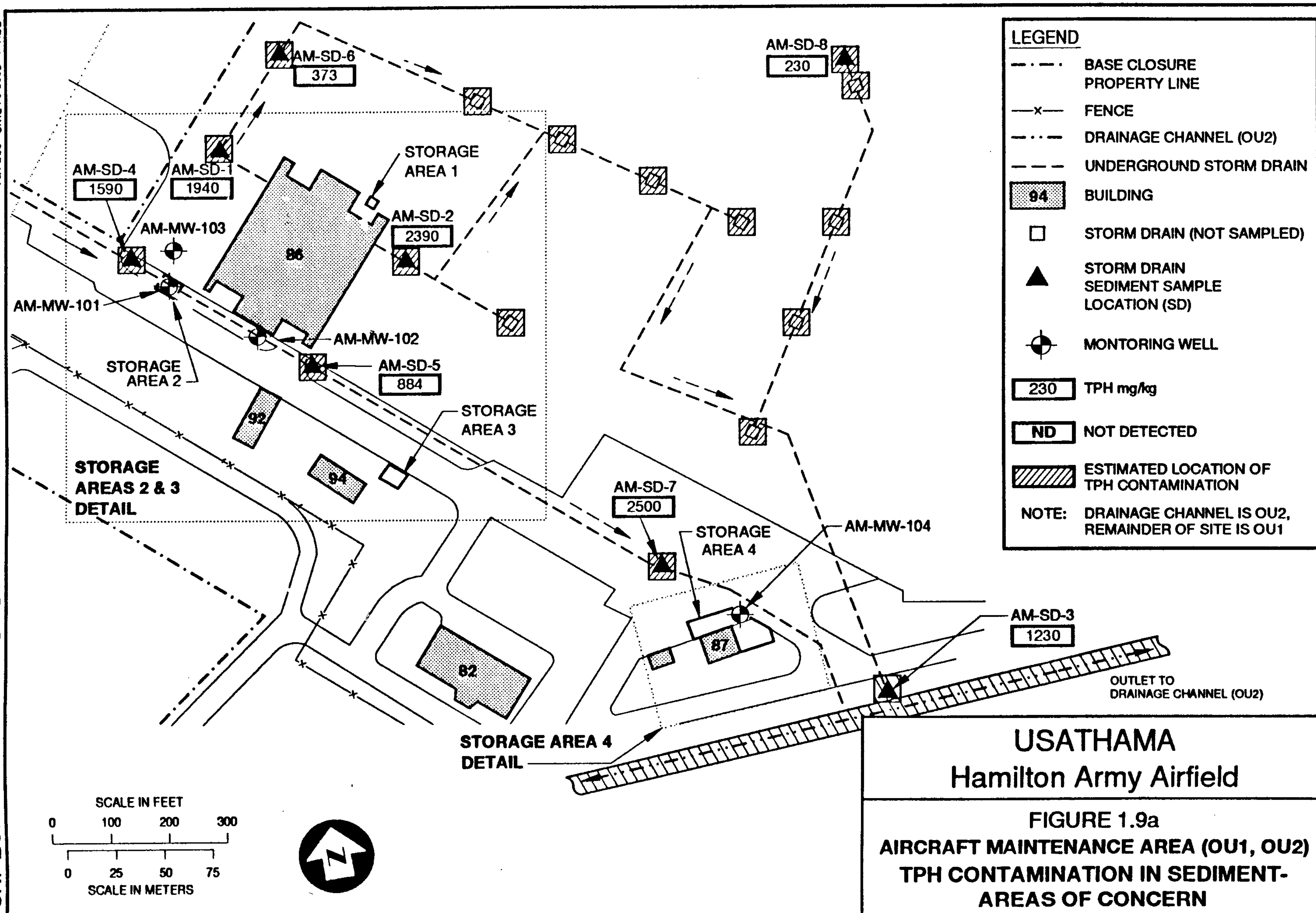

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FIGURE 1.9a
AIRCRAFT MAINTENANCE AREA (OU1, OU2)
TPH CONTAMINATION IN SEDIMENT-AREAS OF CONCERN

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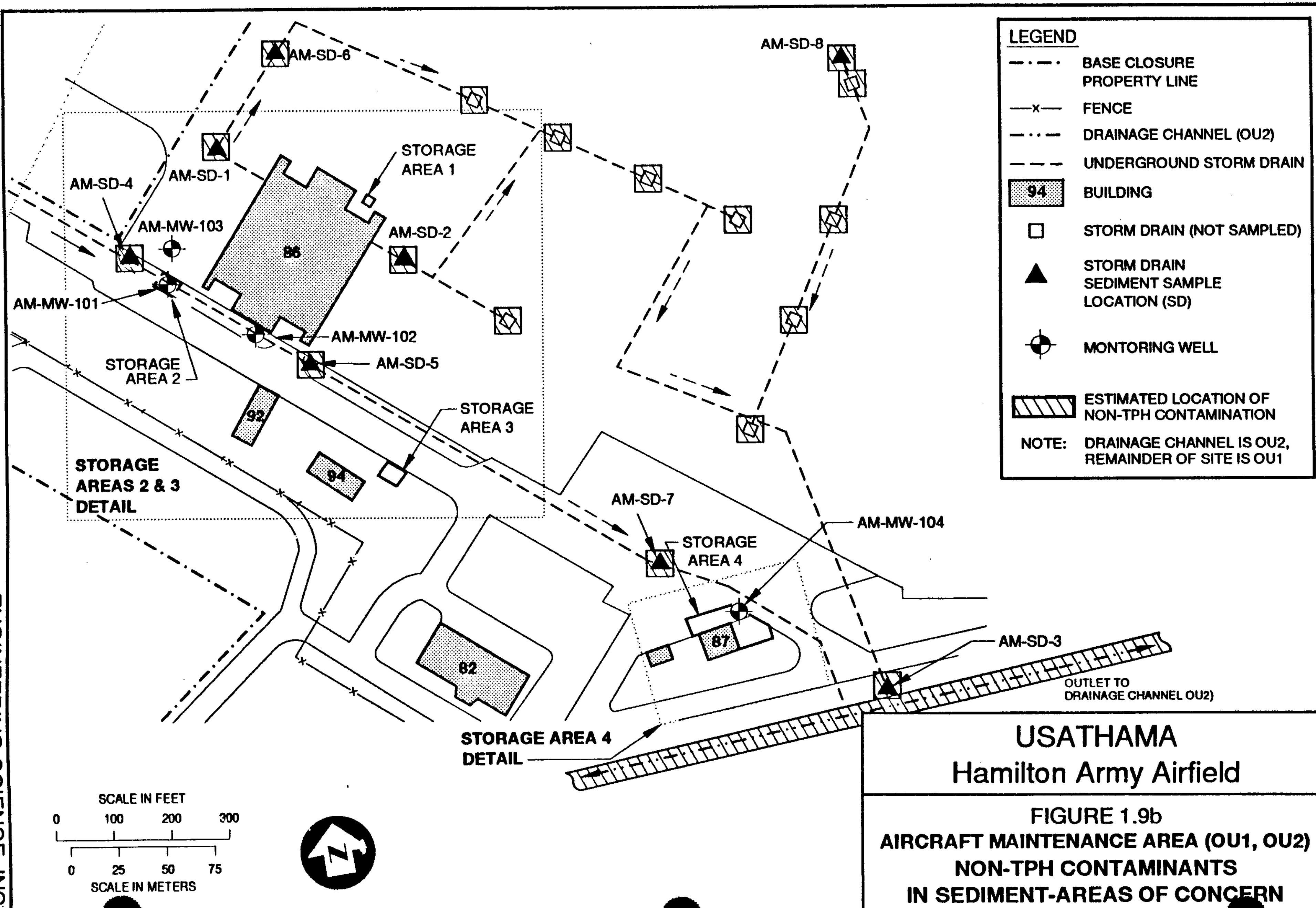

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FIGURE 1.9b
AIRCRAFT MAINTENANCE AREA (OU1, OU2)
NON-TPH CONTAMINANTS
IN SEDIMENT-AREAS OF CONCERN

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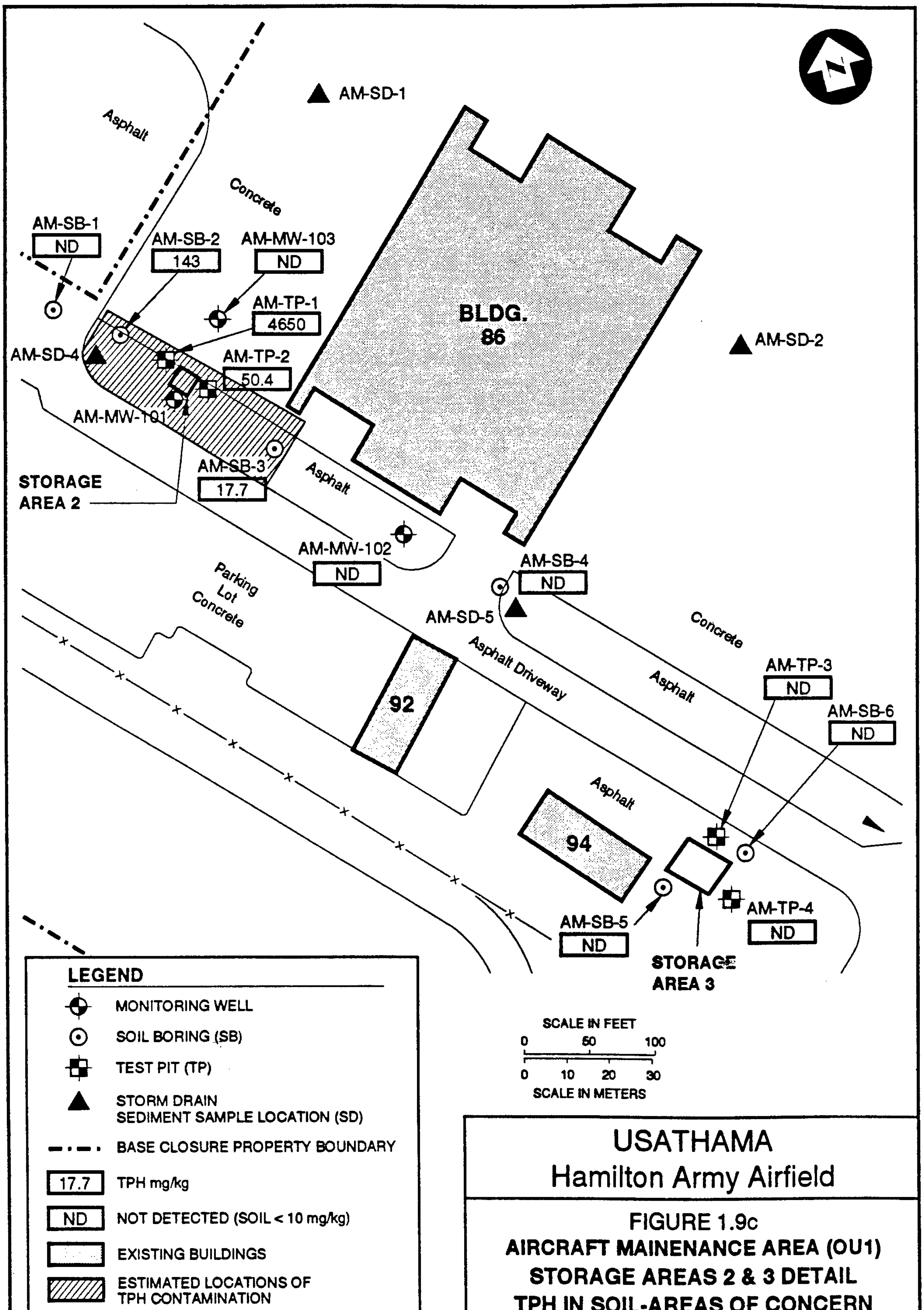

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FIGURE 1.9c
AIRCRAFT MAINENANCE AREA (OU1)
STORAGE AREAS 2 & 3 DETAIL
TPH IN SOIL-AREAS OF CONCERN

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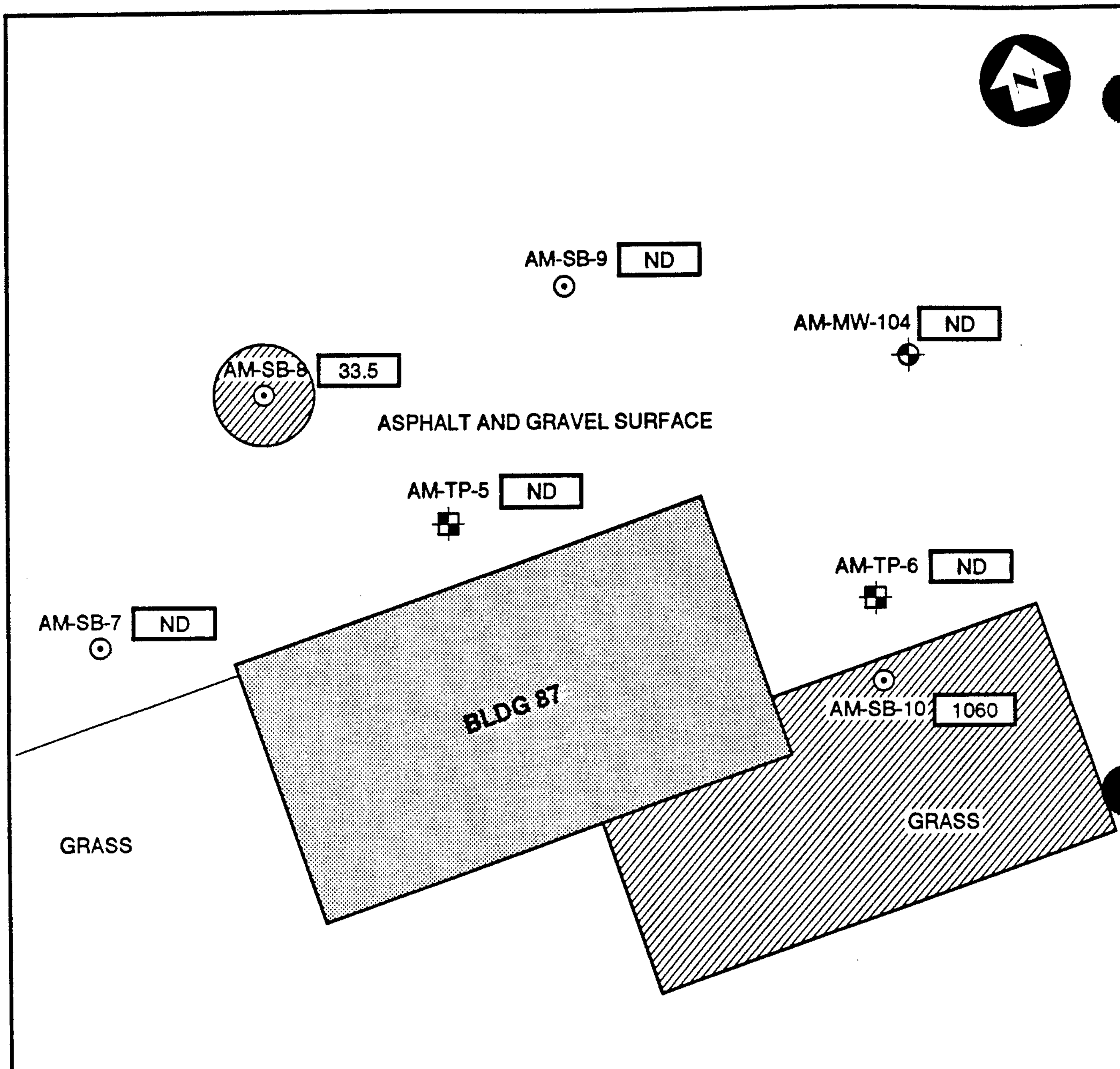

LEGEND

- MONITORING WELL
- TEST PIT (TP)
- SOIL BORING (SB)
- EXISTING BUILDING
- 33.5 TPH mg/kg
- ND NOT DETECTED (SOIL < 10 mg/kg)
- ESTIMATED LOCATION OF TPH CONTAMINATION

NOTE: AREA OF CONCERN DETERMINED BY ADDITIONAL TPH DATA FROM CORPS OF ENGINEERS (APRIL 1994)

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FIGURE 1.9d
AIRCRAFT MAINTENANCE AREA STORAGE AREA 4 (OU1) TPH IN SOIL-AREAS OF CONCERN

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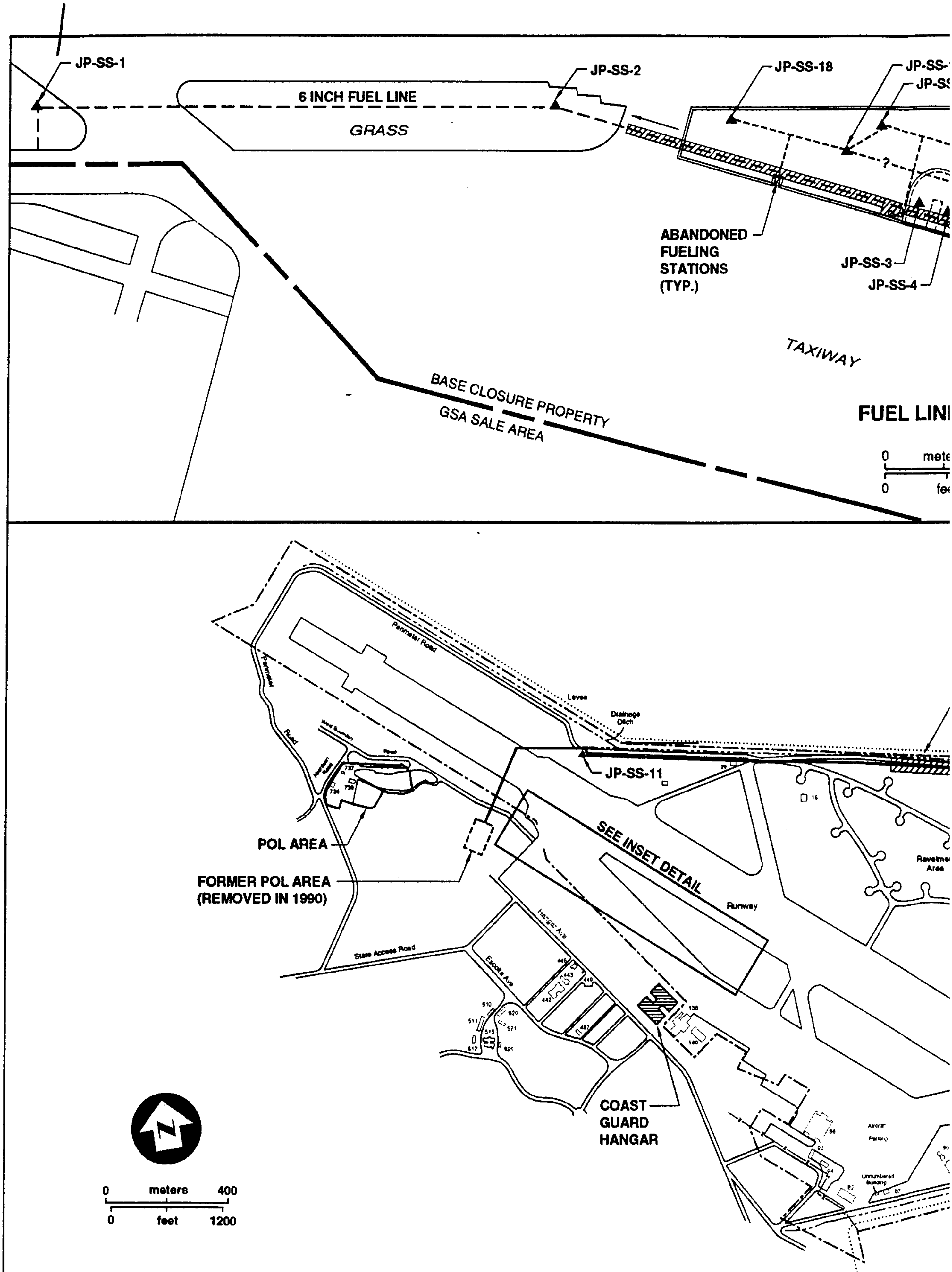

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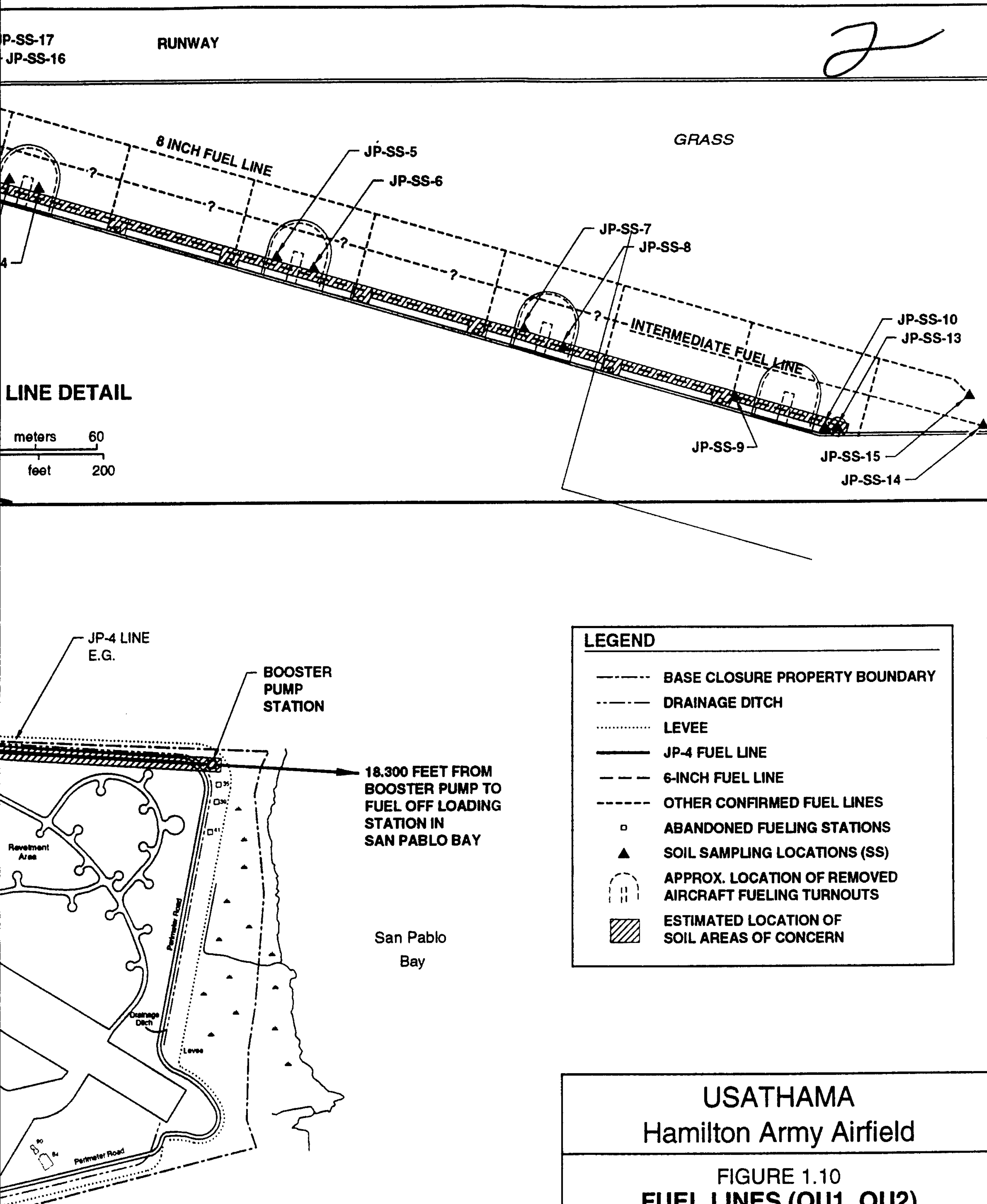

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FIGURE 1.10
FUEL LINES (OU1, OU2)
SOIL AREAS OF CONCERN
(10ppm TPH cleanup goal)

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soil samples and the soil gas survey conducted during the EI found no detectable levels of TPH or BTEX in the soils. Sampling locations are shown in Figure 1.11.

In another recent consultant's study two soil borings were drilled and a monitoring well was installed (H+GCL, 1992). Based on the map appearing in that report, one boring was located about 50 feet to the northwest of AST-11 near the main entrance steps of Building 442; the other boring was drilled about 10 feet from the AST near soil gas probe location 8. Three soil samples were collected from depths of 4, 6.5 and 9 feet. The analytical results for TPH/diesel (TPHd) (modified EPA Method 8015) were 1.1 to 2.1 mg/kg and not-detectable (ND) for aromatic hydrocarbons BTEX (EPA Method 8020).

The monitoring well is located several feet north of BL-SS-2 (Figure 4.24). Although groundwater depth was not recorded here, the boring log for the monitoring well indicates that depth to water was about 5 feet. Results of the water analysis for TPH/d was 100 µg/L and BTEX analysis yielded 0.5 µg/L xylene and 0.6 µg/L ethylbenzene.

In a follow-up study, the USAEC sampled a total of five soil borings: three within 10 feet of AST-11, one about 20 feet from the tank, and one at a background location across the street. Soil samples were taken from the surface and at a depth 2 feet in each boring. Groundwater was collected from the monitoring well and from one of the borings near the tank by hydropunch method. Results of TPHd, TPHjp4 (modified EPA Method 8015), and BTEX (EPA Method 8080) analyses on all soil and water samples were below detection limits (Potter 1993, and USAEC 1993b).

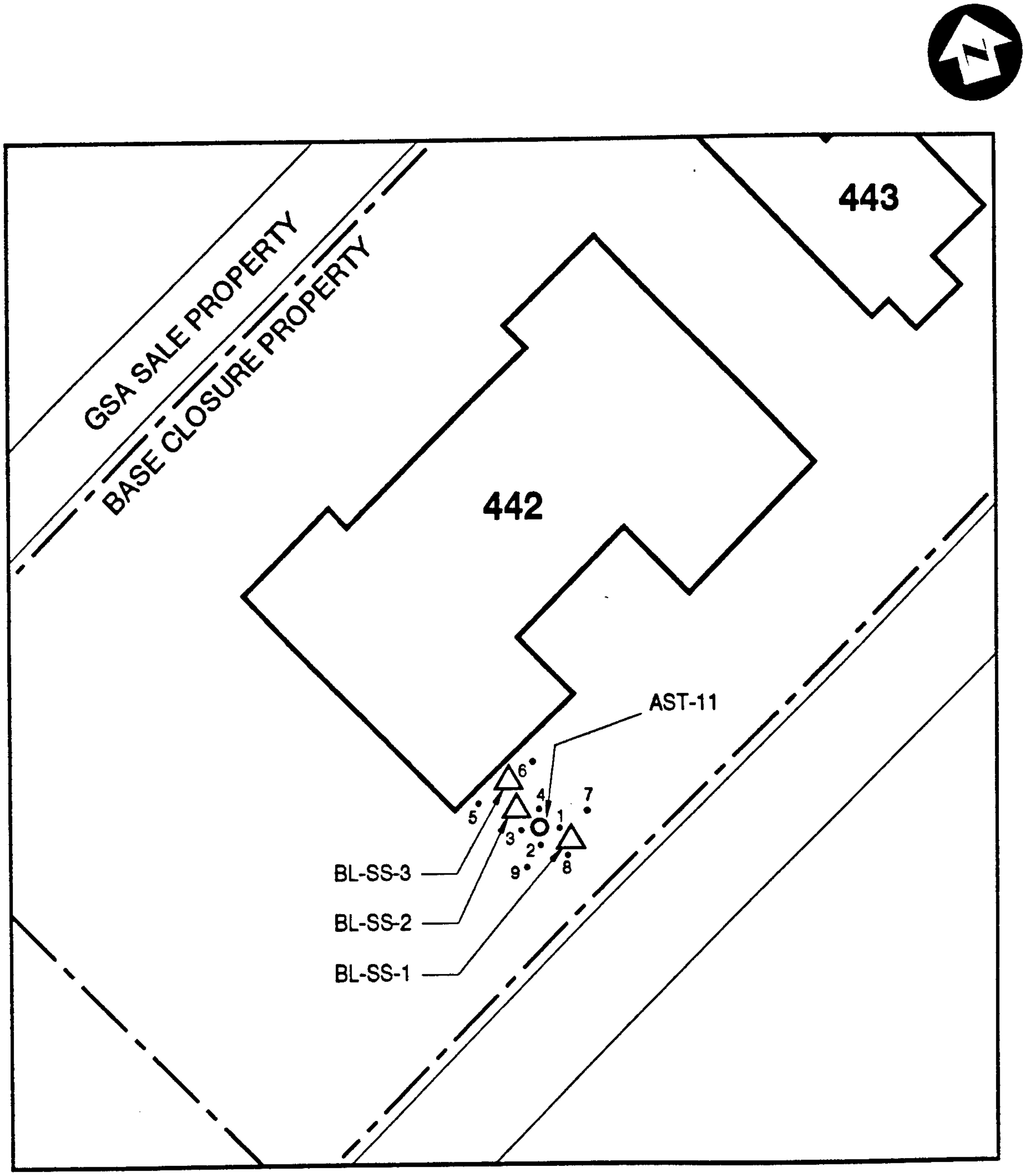
1.2.3.1.10 Extent of Contamination (Site 10 - Transformer and Oil-containing Items). Transformers and other oil bearing equipment were surveyed for PCBs. The transformers and other oil bearing appliances were scattered at different areas of the base. The results are grouped together in this report as a site. Seventy (70) transformers were identified and 54 required sampling. Seven transformers were found to contain PCB above 50 parts per million (ppm). No capacitors or hydraulic lifts were identified within the base closure property area. Thirty-one (31) oil-filled switches and circuit boxes were surveyed and six were sampled. PCB was detected at levels less than 50 ppm.

The appliances found to contain PCB will be drained. Disposal and treatment will follow TSCA regulations (40 CFR 761).

1.2.3.2 Site Areas of Concern - Groundwater

EI results indicate that the POL Area, Burn Pit, Former Sewage Treatment Plant, and Aircraft Maintenance have groundwater contaminant concentration above Maximum Contaminant Levels (MCLs) or above 100 mg/L TPH. The nature and extent of contamination and relevant hydrogeologic conditions associated with HAA is described in this subsection.

1.2.3.2.1 Extent of Groundwater Contamination (Site 1: POL Area). The POL Area contains two distinct bedrock types and two fill units. The flat-lying areas that lie immediately north and northeast of the hill have 5 to 7 feet of fill lying upon a yellow to buff-colored weak sandstone unit. In the former tank farm area, the fill is clayey, sandy gravel that was placed in 1991 following excavation of fuel-contaminated soil and rock.



LEGEND

- SOIL GAS PROBE LOCATION
- ABOVE GROUND STORAGE TANK
- SOIL BORING LOCATION

SCALE IN FEET
0 50 100
0 10 20 30
SCALE IN METERS

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FIGURE 1.11
BUILDING 442 (OU1)
SAMPLING LOCATIONS

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In the paved area surrounding Buildings 736 and 737 and along the fence line north of the tank farm the fill is older pebbly sandy clay. The hill consists of hard, gray, fractured sandstone. Monitoring wells PL-MW-101, 103, 104, 114 and 115 were drilled entirely within this hard rock unit.

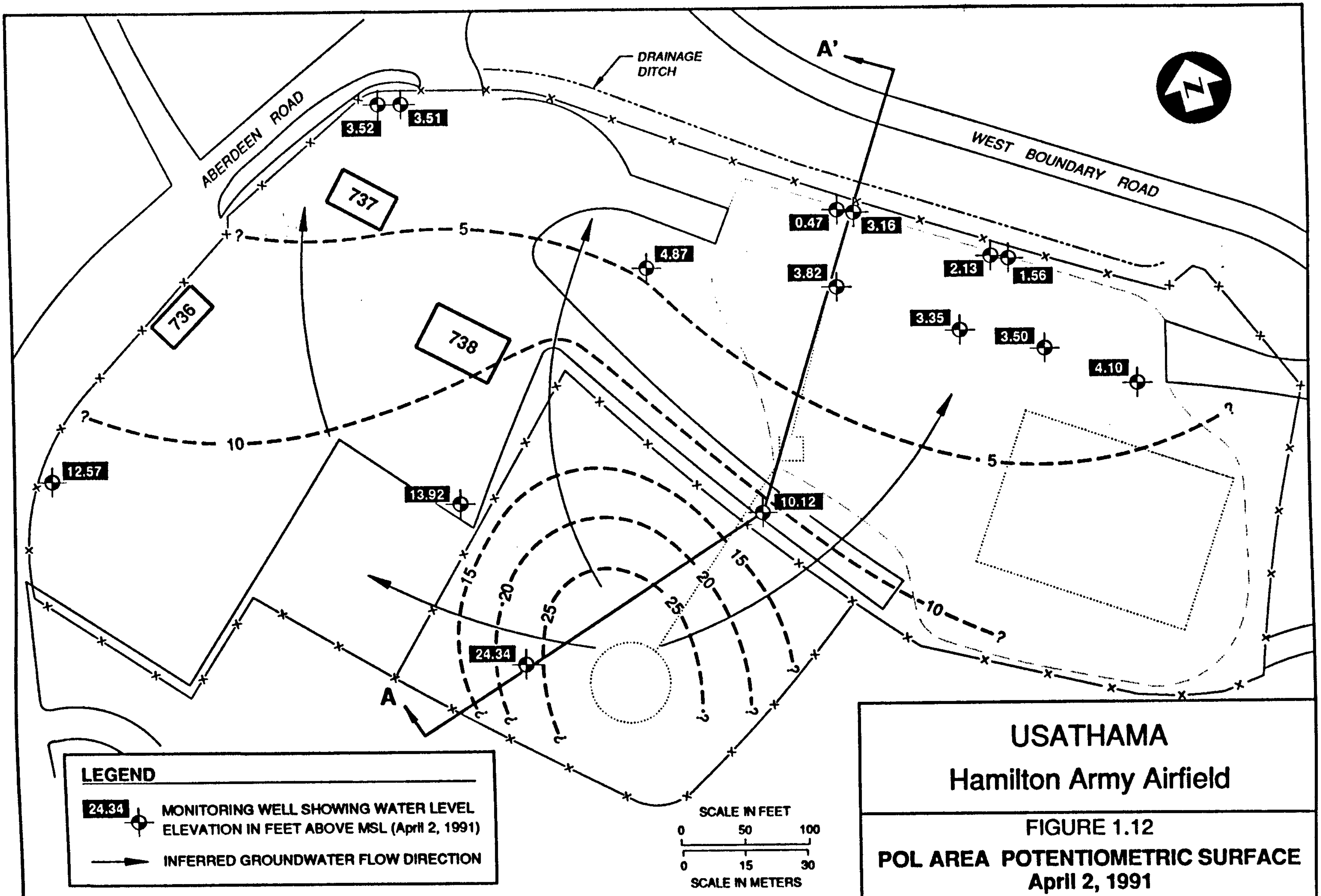
Groundwater levels measured in April 1991 and again in July/August 1992 show a lateral hydraulic gradient corresponding to the topography. This gradient suggests contamination will migrate radially away from Reservoir Hill. Hydraulic well testing described in the EI yielded hydraulic conductivity values that are generally low ranging from $1x10^{-7}$ to $3x10^{-5}$ feet/second.

Water level data also suggest that a slight upward vertical gradient exists between the shallow and deeper portions of the bedrock. This is a favorable condition that would tend to inhibit downward migration of contamination. Figure 1.12 is a potentiometric surface map of the POL Area.

Groundwater contamination identified was principally TPH associated with the hillside bench location of the above ground storage tank, AST-2, as shown in Figure 1.13. Appendix A summarizes the maximum concentrations all contaminants identified at the POL area, the number of samples with detectable contaminant concentrations and the average concentration of detectable samples. The contaminant concentration map (Figure 1.13) shows that the TPH contamination plume appears to be confined to the hillside area within several hundred feet of the former AST-2 location, with detectable concentrations of TPH at monitoring wells MW-101 (14,000 µg/L) and MW-104 (550 µg/L). Total VOCs (4,720 µg/L) and total SVOCs (1,474 µg/L) were also detected in well MW-101. The general direction of the AST-2 area groundwater contamination plume is probably moving slowly radially away from the hill. A portion of this contamination may be moving in a westerly direction toward Landfill 26 in the GSA Sale Property. The rate of migration appears to be very slow as suggested by the lack of significant detectable groundwater contamination at downgradient wells. Hydraulic testing of well MW-101 provided a hydraulic conductivity value of $1.2x10^{-7}$ feet/sec which corresponds to an estimated groundwater velocity of 6 feet per year.

1.2.3.2.2 Extent of Groundwater Contamination (Site 2: Burn Pit). Hydraulic testing of all four wells at the Burn Pit was undertaken in the EI in order to quantify hydraulic conductivity of the Bay Mud in this area. Only falling head data from those tests yield quantitative results, and fall within a relatively narrow range ($5.9 \times 10^{-7} \pm 4.3 \times 10^{-7}$ feet/sec). Estimated values of hydraulic conductivity derived from the rising head data, although only semiquantitative, all fell within the range of values derived from the falling head tests. These values are typical of clays in general.

The water table in the Burn Pit Area displays periodic fluctuations in response to rainfall as indicated by periodic monitoring of water levels from December 1990 to May 1991. From December 1990 to early February 1991, elevation of the water table surface measured in the four installed monitoring wells stayed fairly constant at approximately 13 feet below mean sea level (8.5 feet bgs). These measurements indicate that slight hydraulic gradients (<1 feet/100 feet) occur at the Burn Pit; however, the gradient



USATHAMA

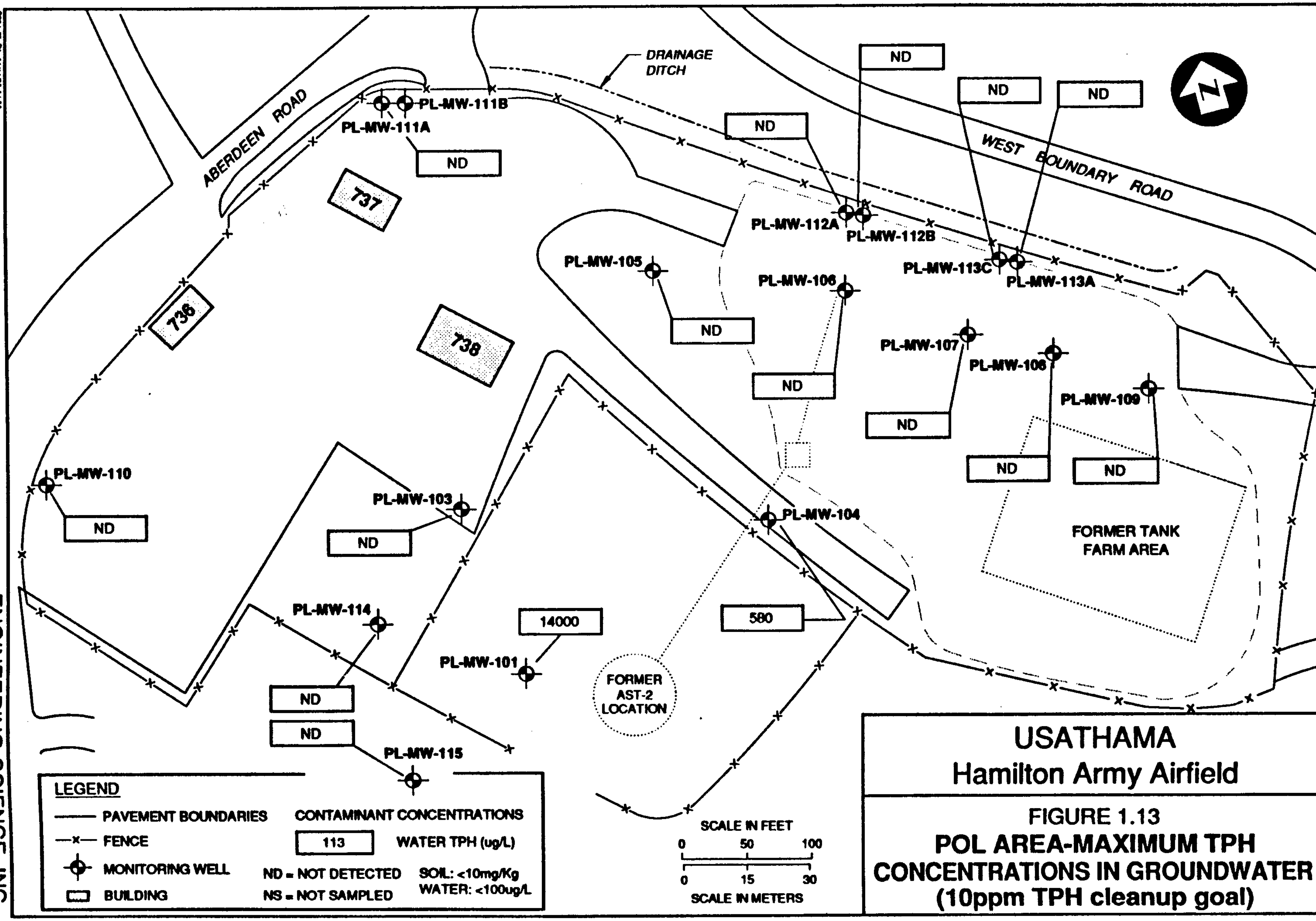
Hamilton Army Airfield

FIGURE 1.12

POL AREA POTENTIOMETRIC SURFACE

April 2, 1991

ENGINEERING-SCIENCE



USATHAMA
Hamilton Army Airfield

FIGURE 1.13
POL AREA-MAXIMUM TPH CONCENTRATIONS IN GROUNDWATER (10ppm TPH cleanup goal)

magnitude and direction varies with time. For this reason, the hydraulic gradient can be considered flat within the resolution of the data. The EI estimated an average lateral groundwater velocity on the order of 4 inches per year.

The only identified organic analyte other than TPH found in the groundwater was methyl ethyl ketone (MEK). MEK was found in each of the wells at concentrations between 25 and 30 μg/L. There are no MCLs or MCLGs for MEK.

Lead was detected in groundwater in wells 102 and 103 at 7 to 9 μg/L, below the California MCL for drinking water (50 μg/L). Lead was ND (<4.5 μg/L) in wells 101 and 104.

1.2.3.2.3 Extent of Groundwater Contamination (Site 3: Revetment Area). Groundwater quality was assessed by installing three monitoring wells screened across the water table. Two rounds of groundwater samples were collected from well RV-MW-101 at the Engine Test Pad and from RV-MW-103 (near Pad 20). Well RV-MW-102 did not recharge sufficiently for sampling. These samples were analyzed for VOCs, SVOCs, TPH and lead. In addition one round of samples from RV-MW-101 were analyzed for metals and cyanide as well. None of the detected analytes exceeded MCLs.

1.2.3.2.4 Extent of Groundwater Contamination (Site 4: Pump Station). One groundwater monitoring well was installed at the north end of the Pump Station site near AST-6. Groundwater was encountered approximately 4.4 feet bgs. Hydraulic testing was undertaken in order to estimate the hydraulic conductivity of the Bay Mud there. Hydraulic conductivities calculated from two tests were 2.3×10^{-7} ($\pm 2.0 \times 10^{-8}$) and 1.4×10^{-7} ($\pm 7.9 \times 10^{-8}$) feet/sec. These values are within the range of values calculated elsewhere in Bay Mud.

Tidal fluctuations do not appear to influence groundwater at the Pump Station. The monitoring well (PS-MW-101) is located between the storm drainage ditch, which is 15 feet below sea level, and the tidal wetlands which is 4 to 6 feet above sea level on the other side of the levee. Thus, the hydraulic gradient across the Pump Station area has a relatively steep slope of approximately 1 feet/10 feet downgradient towards the air field.

The groundwater from the well PS-MW-101 had no anomalies other than 32 μg/L MEK. There are not MCLs or MCLGs for MEK.

1.2.3.2.5 Extent of Groundwater Contamination (Site 5: Former Sewage Treatment Plant). Hydraulic testing of monitoring well TP-MW-101 was undertaken in the EI in order to quantify hydraulic conductivity of materials encountered during drilling. Hydraulic conductivities calculated from the tests all fell within the range $1.8 \times 10^{-5} \pm 1.5 \times 10^{-5}$ feet/sec. These values are approximately two orders of magnitude higher than values calculated for wells screened in undisturbed Bay Mud.

The water table at the Former Sewage Treatment Plant Area is controlled by the geometry of the tidal wetlands and the perimeter drainage ditch. The tidal wetlands and channel complex, which lie adjacent to the east side of the levee are at higher elevation than the entire Former Sewage Treatment Plant area, except for the upper few feet of the levee, and are perennially saturated, even at low tide. Therefore, the high datum on the

water table always lies at approximately 4-6 feet above mean sea level on the outside edge of the levee. The drainage ditch, which lies at approximately 15 feet below sea-level on the west side of the Former Sewage Treatment Plant area, is the lowest point at HAA, and, as it is generally kept essentially dry by pumping, is the lower datum on the water table. Thus, the average hydraulic gradient across the Former Sewage Treatment Plant has a relatively steep slope of approximately 1 feet/10 feet, downgradient towards the airfield. The EI estimated the average groundwater velocity of about 250 feet per year.

The water analyses indicate that the water is non-potable due to very high salinity (>5,000 µS/cm EC), total dissolved solids (TDS) (>3,000 mg/L), and secondary standards for metals such as iron and manganese. In addition, the low yield (<200 gallons per day) indicated by recharge in monitoring wells makes this groundwater essentially non-recoverable and thus not of beneficial use as a potential drinking water source.

The seep water analyses included no detections of organic compounds. However, the groundwater from well TP-MW-101 contained 300 to 370 µg/L total VOCs and 290 to 350 µg/L total SVOCs (Table 4.20a in Appendix A).

1.2.3.2.6 Extent of Groundwater Contamination (Site 6: East Levee Landfill). Five groundwater monitoring wells are installed at the East Levee Landfill. The hydraulic conductivity of each of the wells fell within the range of $4.9 \times 10^{-7} \pm 3.7 \times 10^{-7}$ feet/sec, indicating that the landfill area is relatively homogenous. These values fell within the range of values for Bay Mud.

The tidal wetlands at the East Levee Landfill are commonly inundated at high tide. The hydraulic gradient oscillates between a northward and a southward slope direction as influenced by tidal water level fluctuations in the channel. The average water level in all the wells varies from 1 foot to 2 feet bgs.

The groundwater analyses showed only one organic detection, 28 µg/L MEK in well EL-MW-101. The inorganic analyses showed that the water is saline and high in dissolved metals and ions. There are no MCLs or MCLGs for MEK, and the other detected analytes did not exceed MCLs.

1.2.3.2.7 Extent of Groundwater Contamination (Site 7: Aircraft Maintenance). During the EI hydraulic testing of monitoring well AM-MW-101 installed at Storage Area 2 was completed to estimate hydraulic conductivity of the Bay Mud in this area. Only the rising head test conducted at this well yielded quantitative results, and produced a calculated hydraulic conductivity value of $1.0 \times 10^{-5} \pm 8.5 \times 10^{-7}$ feet/sec. The hydraulic conductivity calculation for the falling head test yielded a value of $7.9 \times 10^{-6} \pm 2.0 \times 10^{-6}$ feet/sec. Values for both tests agree within the precision of each calculation. These values lie within the range of values typical of clays in general, although they are higher than values measured for Bay Mud in more northerly parts of HAA.

In 1991, the water table in this area displayed brief fluctuations in response to rainfall, as indicated by periodic monitoring of water levels in AM-MW-101. The water table appeared to be about 9.5 feet below MSL. The gradient inferred from water levels in the

four monitoring wells indicates that subsurface flow is southeastward toward the perimeter ditch.

TPH was not detected in the groundwater samples taken in Phase II of the EI. Analyses confirmed trace amounts of VOCs in the water although low detections of benzene and 1,2-dichloroethylene (1,2-DCE) in AM-MW-103 (1.16 µg/L, 5.4 µg/L, respectively), located in the taxiway, contained traces of naphthalene and 20 to 210 µg/L of tentatively identified SVOCs.

1.2.3.2.8 Other Sites. No groundwater investigation was performed for Site 8 (Fuel Lines) and Site 9 (Building 442) as part of the EI. Soil contamination at Site 8 (Fuel Lines) appeared to be confined to small volumes or pockets scattered along the JP-4 fuel line and the 6-inch fuel line which are both in low permeability soils. It was determined and agreed to by the SFRWQCB, in a meeting held at HAA on 5 December 1991 to determine the scope of 1992 sampling, that trying to assess groundwater contamination along the Fuel Lines would not be necessary.

1.2.4 Contaminant Fate and Transport

As stated in Section 1.2.3, contamination has been found in surface soil (defined for this assessment as soil from 0 to 2 feet in depth) in soil deeper than 2 feet, in bedrock at certain locations (POL area), in sediments, and in groundwater associated with the Base Closure Property. The potential for contaminant transport from each of these media is discussed in the following paragraphs.

Contaminants could enter surface water within the Base Closure Property in several ways: discharge (current or historical), seepage from contaminated groundwater, and runoff from contaminated surface soils.

Since the Base is mostly below sea level and is maintained dry through continuous dewatering, groundwater from the site cannot seep directly into the San Pablo Bay. Runoff carries contaminants from surface soil through the Base perimeter ditch to San Pablo Bay (via the Pump Station outfall) and, to a very limited extent, to Pacheco Creek. These contaminants can either be dissolved or suspended and transported with the water or become adsorbed to sediment particles, thereby becoming less mobile.

The Former Sewage Treatment Plant operated until 1986 and discharged to San Pablo Bay. Therefore, it was a potential historical source of contamination to surface water and sediments. The JP-4 pipeline was used to pump jet fuel from tankers in the Bay to the POL Area. This pipeline could have developed leaks and caused contamination of the water and sediments of San Pablo Bay. Undetected contamination would almost certainly be minor since fuel is lighter than water and would leave a visible sheen for even a small leak, thus alerting operators to the problem. This pipeline is no longer used. Historical discharges are unlikely to have persistence in surface water and are therefore no longer likely to present a significant risk. Discharge from the Pump Station to the Bay is discussed as runoff, since the source of water directed to the Pump Station via the perimeter ditch is mainly the combined surface runoff from the Base Closure Property, the GSA Sale Parcel, and adjacent agricultural lands.

Sources of sediment contamination are similar to those for surface water: discharge to San Pablo Bay sediments and runoff to sediments in the drainage ditches on site, as well as in San Pablo Bay. Direct human contact with sediments is likely only in the case of storm drain maintenance or sewer repair which are infrequent events.

Under present conditions or the development reuse option, surface soil could become contaminated through surface spills or leaks in shallow underground piping. Surface soil could become airborne and be inhaled or ingested by a downwind population; however, this is unlikely to be a chronic exposure pathway under current site use since most of the contaminated areas are either vegetated or paved, which significantly reduces both the likelihood of airborne dust and of direct contact with the soil.

Deeper soil, below 2 feet in depth, can be contaminated either through leaching from surface soil or from leaking USTs.

Potential sources of air contamination include fugitive dust and volatilization from surface soil. Since most of the contaminated areas are either vegetated or paved, this pathway has a low probability of completion. Volatilization can also occur from contaminated groundwater and contaminated deeper soil. Over most of the Base Closure Property, the tight clay would restrict migration. In addition, analyses have shown that throughout the investigated sites, volatile fuel components are generally not present in the soil. The POL area is the only area where such migration might occur. However, well hydraulic tests and repeated monitoring of groundwater indicate limited movement of contamination. The only volatiles detected in groundwater were m-xylene (479 µg/L), benzene (9.69 µg/L), and ethylbenzene (210 µg/L) confined in rock 28 feet below ground surface.

Regardless of which reuse option is selected for the Base Closure Property, the land east of the East Levee is expected to remain tidal wetland. The East Levee Landfill Area and areas bayward from the Former Sewage Treatment Plant Area and Pump Station Area should continue to have low human exposure risks due to limited human access to the contaminants.

Recent investigations by the Corps of Engineers (Corps 1994) found that contamination in the tidal wetland area associated with the Pump Station discharge points is more extensive than previously thought. The new data for metals contamination confirm that the risk to ecological receptors is high (Table 2.3) but it is distributed over an area larger than previously considered. The RWQCB has indicated that further sampling and analyses will be required to complete characterization. Bioassay testing may be necessary and risks may also need to be reevaluated. Because this additional work could not be completed in time for incorporation in the AA report, the Pump Station wetland area has been made part of Operable Unit 2 along with the perimeter drainage ditch sediments.

Under the Wetland Reuse Option, creation of inlet channels and regrading of the levee could lead to remobilization and mixing of contaminated sediments with background sediment from San Pablo Bay in a newly created tidal basin thereby increasing ecological risks.

Under the Wetland Reuse Option, the newly inundated sites would include the Revetment Area (including all but the northwestern end of the runway), the Aircraft Maintenance Area (nearly all of which is paved), and the portions of the Pump Station Area and Former Sewage Treatment Plant that are inboard of the existing levee crest. The POL area and Building 442 sites would not be flooded. The exposures associated with the fuel line sites would not be expected to be affected by flooding. Since most of the soils at the site are tight clays (with the exception of the POL area), contaminants from deeper soil (2-6 feet) and groundwater are not expected to migrate to the surface even under the flooding scenario. It is understood that the Corps of Engineers will remove the fuel lines and associated soil contamination regardless of the selected Base reuse option.

Physical and chemical properties of the chemicals of concern will affect the extent to which they may migrate through the environment. Chemicals of concern for the site are presented in Section 2 (Tables 2.1 and 2.2).

The water solubility of a substance is a critical property affecting environmental fate. Highly-soluble chemicals can be leached rapidly from soils and sediments and are generally mobile in groundwater. Solubilities can range from less than 1 mg/L to totally miscible, with most common organic chemicals falling between 1 mg/L and 1,000,000 mg/L (Lyman et al. 1990). The solubility of chemicals which are not readily soluble in water may become enhanced in the presence of organic solvents (e.g., toluene) which themselves are more soluble in water.

Volatilization of a compound will depend on its vapor pressure, water solubility, and air diffusion coefficient. Highly water-soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from roughly 0.001 to 760 millimeters of mercury (mm Hg) for liquids. The Henry's Law Constant, which is a measure of vapor pressure and solubility, is more appropriate than vapor pressure alone for estimating releases from water to air for compounds having Henry's Law Constants. Compounds with Henry's Law Constants greater than 10^{-3} atmospheres - cubic meter per mole (atm-m^3/mole) can be expected to volatilize readily from water. Compounds with values ranging from 10^{-3} to 10^{-5} are associated with possibly significant but not facile volatilization, while compounds with values less than 10^{-5} will only volatilize from water to a limited extent (Lyman et al. 1990).

The organic carbon partition coefficient (K_{oc}) reflects the propensity of a compound to adsorb to organic matter found in soil. The normal range of K_{oc} values is 1 to 107 milliliters per gram (ml/g), with higher values indicating greater adsorption potential. Chemicals which have a strong tendency to adsorb to organic matter (i.e., chemicals with high K_{oc}s) will move more slowly in the environment than chemicals with low K_{oc}s.

1.2.5 Baseline Risk Assessment

This section summarizes the baseline risk assessment performed in the EI. Based on available data, a public health risk analysis was performed for dermal contact and incidental ingestion of soils and sediment by present and future occupants (Engineering-

TABLE 1.2

EXPECTED HUMAN HEALTH RISKS
HAMILTON ARMY AIRFIELD

Site	Expected Risks: Present Use (Base Employees)	Future Use (Residents)	Future Use (Construction)
POL Area			
Carcinogenic	Very Low	Very Low	Very Low
Noncarcinogenic	Very Low	Very Low	Very Low
Burn Pit			
Carcinogenic	Very Low	Very Low	Very Low
Noncarcinogenic	Very Low	Very Low	Very Low
Revetment Area			
Carcinogenic	Very Low	Very Low	Very Low
Noncarcinogenic	Very Low	Very Low	Very Low
Pump Station			
Carcinogenic	Moderate	Moderate	Low
Noncarcinogenic	High	Low	Very Low
Former Sewage Treatment Plant			
Carcinogenic	Low	Low	Low
Noncarcinogenic	Low	High	Low
East Levee Landfill			
Carcinogenic	Low	Low	Low
Noncarcinogenic	Low	High	Low
Aircraft Maintenance Area			
Carcinogenic	Low	Moderate	Low
Noncarcinogenic	Low	High	Low

Very Low:	Carcinogenic	<1E-6
	Non-Carcinogenic	<0.05
Low:	Carcinogenic	1E-6 to 1E-4
	Non-Carcinogenic	0.05 to 1.0
Moderate:	Carcinogenic	1E-4 to 9E-4
	Non-Carcinogenic	1.0 to 2
High:	Carcinogenic	>9E-4
	Non-Carcinogenic	>2

Note: No human health risk assessment was performed for the Fuel Lines and Building 442 AST sites because the no risk data was available for the analytes identified.

Source: Engineering-Science, Inc., 1993

Table 1.3
Summary of Chemicals of Concern and Environmental Risks

Area	Present Use			Future Wetland Option		
	COC (a)	Receptor Group	Risk Rating	COC	Receptor Group	Risk Rating
POL Area	None	-	None	None	-	None
Burn Pit	None	-	None	None	-	None
Revetment Area	None	-	None	None	-	None
Pump Station	Manganese	Vegetation	Moderate	Manganese	Vegetation	Moderate
	Nickel	Vegetation	High	Nickel	Vegetation	High
		Aquatic Life	High		Aquatic Life	High
	Zinc	Aquatic Life	Moderate	Zinc	Aquatic Life	Moderate
	DDT	Aquatic Life	Moderate	DDT	Aquatic Life	High
	DDD	Aquatic Life	High	DDD	Aquatic Life	High
		Wildlife	High		Wildlife	Moderate-High
				Lead	Aquatic Life	High
				2-Methyl-naphthalene	Aquatic Life	High
				Acenaphthene	Aquatic Life	High
				Benzo[a]anthracene	Aquatic Life	High
				Benzo[a]pyrene	Aquatic Life	High
				Chrysene	Aquatic Life	High
				Dibenzo[a,h]anthracene	Aquatic Life	High
				Fluoranthene	Aquatic Life	High
				Naphthalene	Aquatic Life	High
				Phenanthrene	Aquatic Life	High
				Pyrene	Aquatic Life	High
Former Sewage Treatment Plant	Mercury	Wildlife	High	Mercury	Aquatic Life	High
					Wildlife	High
	DDD/DDE/DDT	Wildlife	High	DDD/DDE/DDT	Aquatic Life	High
					Wildlife	High
	Manganese	Vegetation	Moderate	-	-	-
				Silver	Aquatic Life	High
				Dieldrin	Aquatic Life	High
				Endrin	Aquatic Life	High
East Levee Landfill	None	-	None	None	-	None
Aircraft Maintenance Area	None	-	None	Benzo[a]anthracene	Aquatic Life	Moderate
				Fluoranthene	Aquatic Life	High
				Phenanthrene	Aquatic Life	High
				Pyrene	Aquatic Life	High
Fuel Lines	None	-	None	None	-	None
Bldg 442 AST	None	-	None	None	-	None

(a) COC - Chemical of Concern.
source (Engineering - Science 1993)

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Science, 1993). Tables 1.2 and 1.3 summarize expected human health and environmental risks, respectively. Chemicals of concern for environmental receptors differ from chemicals of concern for human health. Expected human health risks were found to be very low for the POL Area, Burn Pit and Revetment Area. Low to high human health risks were identified for the Pump Station, Former Sewage Treatment Plant, East Levee Landfill, and the Aircraft Maintenance Area. Environmental risk assessments found no risk to low risks associated with the POL Area, Burn Pit, East Levee Landfill, Fuel Lines, Revetment Area and Building 442 AST. The expected environmental risk was moderate to high for the Aircraft Maintenance Area and the Pump Station, and high risks were identified for the Former Sewage Treatment Plant.

Sources of air contamination include fugitive dust generation and volatilization from surface soil. Since most of the contaminated areas are either vegetated or paved, this pathway has a low probability of completion. Volatilization can also occur from contaminated groundwater and contaminated deeper soil. Over most of the Base Closure Property, tight clay would restrict such migration. The POL area is the only area where such migration might occur. However, volatiles compounds detected were at such low concentrations that this source is expected to be negligible. In addition, well hydraulic tests and repeated ground water monitoring indicate no movement of contamination.

1.3 REGIONAL BOARD'S REQUIREMENTS FOR FURTHER SAMPLING

The discussion of the nature and extent of contamination in Section 1.2.3 was derived from the principal findings of the Final Environmental Investigation (EI) Report (Engineering-Science, 1993). The Final EI report was conditionally approved by the SFRWQCB in a letter to USAEC dated July 26, 1993, and modified by a subsequent letter to the Army Corps of Engineers (December 27, 1993). The Board stated that further sampling of soil, sediment, and groundwater needed to be done in certain areas of HAA to complete characterization of site contamination (see Appendix J). These letters also set forth basic requirements for laboratory analyses and for confirmation sampling of remediated areas to be performed during remedial action. The SFRWQCB sampling requirements for further characterization of the HAA property were as follows:

- Install and sample one additional monitoring well in bedrock in the POL Area located downgradient of the former AST-2 site between wells PL-MW-103 and -104
- Perform interim sampling of POL Area wells located downgradient of contaminated wells (PL-MW-101 and -104)
- Collect at least 20 additional sediment samples in the tidal wetlands outside the levee east of the Pump Station Area and the Former Sewage Treatment Plant
- Collect three groundwater samples downgradient of the above ground fuel tanks in the Pump Station Area

- Collect eight groundwater samples at the downgradient side of the FSTP area; requirement modified to four samples (see Appendix J, SFRWQCB letter to the Corps Sacramento District dated December 27, 1993)
- Perform groundwater sampling at the East Levee Landfill; requirement later withdrawn on the basis of information in a supplemental memorandum report (Appendix J, Engineering-Science, Inc., October 1, 1993).
- Collect additional sediment samples from the perimeter drainage ditch in the vicinity of the Aircraft Maintenance Area storm drain discharge points
- Collect four additional shallow soil samples in Storage Area 4 of the Aircraft Maintenance Area
- Perform modified California Waste Extraction Test (WET) procedures on selected sediment samples to evaluate contaminant solubility and potential mobility

All of the above items have been completed by the Corps of Engineers, Sacramento District. The results of this study are reported in the Supplement to the Final EI Report (Corps 1994). The supplementary EI findings are not presented herein, but the data have been utilized in the Alternatives Assessment to refine estimates of contaminated soil volumes and remediation costs and to aid in the selection of preferred alternative treatment methods.

SECTION 2

IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

2.1 REMEDIAL ACTION OBJECTIVES

Since the ultimate future use of the airfield property has not been determined at this time, the remedial action objectives address potential land use options. Three potential options for future land use of the airfield have been identified (Jordan 1990a):

(1) sale to a private developer;

(2) inundate with water to create an artificial wetland; and

(3) use as a civilian airport.

Of the three options being considered, option 1, sale to private developer, will likely result in the greatest degree of human exposure to contaminants, if the developer converts the property to residential use. Option 2, creation of an artificial wetland, will likely present the greatest degree of environmental risk. The baseline human health and environmental risk assessments were conducted based on these two conservative options, as a part of the EI. Option 3 was evaluated in the Risk Assessment and the conclusions were found to be similar to the ecological risk conclusions for the present use conditions and the human health risk conclusions for the Development Option. Since no specific plan has been offered for constructing the airport, a specific description could not be provided in the AA. However, the pertinent risk scenarios have been evaluated. The remedial action objectives address both options 1 and 2.

The primary objectives of remedial action at HAA are as follows:

- Prevent potential risks to public health and environment resulting from migration of existing contamination from soil to groundwater and surface water
- Prevent potential risks to public health and environment resulting from future use of groundwater
- Prevent potential risks to human health and the environment from contamination which presently exists in the groundwater

To achieve the remediation objectives, Preliminary Remediation Goals (PRGs) and other appropriate cleanup goals have been identified to assist in the selection of remedial alternatives. To address remediation objectives, potential contaminants of concern are

identified. Concentration of contaminants of concern at each site are then screened against potential remediation goals. Remediation goals are discussed further in Section 2.1.3. The remainder of Section 2.1 describes contaminants of concern and the formulation of PRGs and other cleanup goals.

2.1.1 Contaminants of Concern

The types of contaminants of concern include petroleum hydrocarbons, VOCs, SVOCs, metals and limited cases of cyanide, pesticides and herbicides. Table 1.1 in Section 1 presented a summary of contaminant types identified at each site. Sixty-six compounds were identified as potential contaminants of concern as shown in Table 2.1 (Engineering-Science 1993). Relevant Physical and Chemical properties of these compounds are provided in Table 2.2.

Analytical results in the EI included tentatively identified compounds (TICs) for organic compounds within the VOCs and SVOCs groups, however, by definition, TICs are compounds not normally included in the EPA Method 8240 and 8270 for VOCs and SVOCs, therefore TICs are not identified as chemicals of concern and no cleanup goals were identified. However, TICs are addressed in the detailed evaluation of remediation alternatives if the concentrations of TICs for VOCs were identified.

2.1.2 Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121 of the Superfund Amendments and Reauthorization Act (SARA) establishes cleanup criteria for Superfund sites. This section of the statute sets forth the need for appropriate remedial actions, consistent with the National Contingency Plan (NCP), that provide a cost-effective response. Subsection (d) of Section 121 requires that remedial actions attain a standard of performance that is equivalent to ARARs promulgated under federal or state laws.

Identification of ARARs is performed on a site-specific basis and involves a two-part analysis: first, determining whether or not a requirement is applicable; and then, if it is not applicable, determining whether it is nevertheless both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, compliance is required as if it were applicable.

"Applicable requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. "Relevant and appropriate requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable to a hazardous substance, pollutant contaminant, remedial action, location, or other circumstance at a CERCLA site", address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Non-promulgated advisories or guidance documents issued by federal or state governments do not have the status of potential ARARs under CERCLA. However, they

TABLE 2.1
CONTAMINANTS OF CONCERN

Metals	Volatile Organics	Semivolatile Organics	Pesticides/Herbicides
aluminum	benzene	acenaphthene	aldrin
arsenic	chlorobenzene	acenaphthylene (acenaphthalene)	beta-benzene hexachloride (beta-HCH, beta BCH)
barium	chloroform	anthracene	2,2-bis(p-chlorophenyl)-1,1-dichloroethane; (DDD)
beryllium	1,2-dichloroethene	benzo(a)anthracene	2,2-bis(p-chlorophenyl)-1,1-trichloroethane;(DDT)
boron	ethylbenzene	benzo(a)pyrene	dieldrin
cadmium	methylene chloride	benzo(b)flouranthene	dichlorodiphenyl dichloroethane (DDE)
chromium	1,1,2,2-tetrachloroethane	benzo(ghi)perylene	endrin
cobalt	toluene	benzo(k)fluoranthene	endrin ketone
copper	m-xylene	bis(2-ethylhexyl)phthalate	isodrin
lead	xylenes	chrysene	heptachlor epoxide
manganese		dibenzofuran	2,4,6-trichlorophenol
mercury		dibenz(a,h)anthracene	
nickel		di-n-butylphthalate	Others
selenium		fluoranthene	cyanide
silver		fluorene	fluoride
tin		indeno(1,2,3-cd)pyrene	nitrate
vanadium		2-methyl naphthalene	PCB 1254
zinc		4-methyphenol	Total Petroleum Hydrocarbons (TPH)
		naphthalene	
		phenanthrene	
		phenol	
		pyrene	

Table 2.2
Relevant Physical and Chemical Properties of Chemicals of Concern Hamilton Army Airfield

CAS Number	Material Name	Analyt Class	Chlor (Y/N)	Mol Wt	Spec Grav	Solubility (mg/L) (1)	Vapor Pressure (mm Hg) (1)	Henry's Law K (atm-m3/mole) (1)	Kow (1)	Koc (1)	BCF (1)
83-32-9	Acenaphthene	S	N	154	1.02	3.47E+00	1.55E-03	7.92E-05	2.14E+04	1.78E+01	2.40E+02
208-96-8	Acenaphthylene	S	N	152	0.90	3.93E+00	2.90E-02	2.80E-04	1.17E+04	4.79E+03	5.62E+02
309-00-2	Aldrin	T	Y	365	1.70	1.75E-02	6.00E-06	4.96E-04	4.57E+05	4.07E+02	2.82E+01
7429-90-5	Aluminum (and compounds)	M	N	27	2.70	NA	NA	NA		1.51E+02	3.02E+02
120-12-7	Anthracene	S	N	178	1.28	7.50E-02	1.95E-04	6.51E-05	3.47E+04	2.57E+04	9.12E+02
7440-38-2	Arsenic (and compounds)	M	N	75	5.73	NA	NA	NA			4.37E+01
7440-39-3	Barium (and compounds)	M	N	137	3.60	NA	NA	NA			1.00E+01
71-43-2	Benzene	V	N	78	0.87	1.79E+03	9.52E+01	5.48E-03	1.41E+02	1.00E+02	5.25E+00
319-85-7	Benzene hexachloride (beta-)	T	Y	291	1.89	7.00E-01	2.80E-07	2.30E-07	3.16E+04	3.57E+03	1.29E+02
56-55-3	Benzo(a)anthracene	S	N	228	1.27	1.40E-02	1.10E-07	8.00E-06	8.13E+05	1.38E+06	1.00E+04
50-32-8	Benzo(a)pyrene	S	N	252	1.35	4.00E-03	5.60E-09	2.40E-06	3.16E+06	1.95E+06	1.35E+05
205-99-2	Benzo(b)fluoranthene	S	N	252		1.20E-03	5.00E-07	1.20E-05	3.72E+06	5.50E+05	2.40E+04
191-24-2	Benzo(g,h,i)perylene	S	N	252		2.60E-04	1.01E-10	1.40E-07	1.26E+07	7.76E+06	5.01E+04
207-08-9	Benzo(k)fluoranthene	S	N	252		5.50E-04	9.59E-11	1.04E-03	7.08E+06	4.37E+06	3.39E+04
7440-41-7	Beryllium (and compounds)	M	N	9	1.85	NA	NA	NA	4.47E+07		1.58E+01
117-81-7	Bis(2-Ethylhexyl)phthalate	S	N	391	0.99	4.00E-01	6.20E-08	1.10E-05	1.58E+04	1.00E+05	1.38E+04
	Boron	M	N	11		NA	NA	NA			
7440-43-9	Cadmium (and compounds)	M	N	112	8.65	NA	NA	NA			8.13E+01
108-90-7	Chlorobenzene	V	Y	113	1.10	5.03E+02	1.18E+01	4.45E-03	9.55E+02	3.31E+02	1.00E+01
67-66-3	Chloroform	V	Y	119	1.48	9.30E+03	1.98E+02	3.20E-03	9.33E+01	4.37E+01	3.72E+00
7440-47-3	Chromium (and compounds)	M	N	52	7.14	NA	NA	NA			1.58E+01
218-01-9	Chrysene	S	N	228	1.27	6.00E-03	6.30E-09	7.26E-20	8.13E+05	2.45E+05	1.17E+04
7440-48-4	Cobalt (and compounds)	M	N	59	8.90	NA	NA	NA			
7440-50-8	Copper (and compounds)	M	N	64	8.94	NA	NA	NA			2.00E+02
57-12-5	Cyanide (and compounds)	M	N	26		7.50E+04	1.11E+02	6.30E-01	4.57E-01	1.58E+01	3.24E-01
72-54-8	DDD (4,4'-Dichlorodiphenyldichloroethane)	T	Y	320	1.48	1.00E+02	1.02E-06	2.16E-05	1.05E+06	4.37E+04	7.94E+04
72-55-9	DDE (4,4'-Dichlorodiphenylchloroethane)	T	Y	318		1.20E-01	6.49E-06	2.34E-05	6.76E+05	1.00E+06	5.13E+04

Table 2.2 (continued)
Relevant Physical and Chemical Properties
of Chemicals of Concern
Hamilton Army Airfield

CAS Number	Material Name	Analyt Class	Chlor (Y/N)	Mol Wt	Spec Grav	Solubility (mg/L) (1)	Vapor Pressure (mm Hg) (1)	Henry's Law K (atm-m3/ mole) (1)	Kow (1)	Koc (1)	BCF (1)
50-29-3	DDT (4,4'-Dichlorodiphenyltrichloroethane)	T	Y	355	1.56	4.00E-03	1.90E-07	1.03E-04	2.75E+06	1.82E+06	5.37E+04
53-70-3	Dibenz(a,h)anthracene	S	N	278	1.28	2.49E-03	1.00E-10	7.33E-09	3.16E+06	1.66E+06	1.00E+01
132-64-9	Dibenzofuran	S	N	168	1.09	1.00E+01		NA	2.04E+04	1.26E+04	3.31E+02
60-57-1	Dieldrin	T	Y	381	1.75	2.00E-01	1.80E-07	5.80E-05	3.02E+05	3.55E+04	4.79E+03
84-74-2	Di-n-Butylphthalate	S	N	278	1.04	4.50E-03	1.40E-05	6.30E-05	6.17E+04	1.38E+03	6.03E+02
7421-93-4	Endrin (aldehyde form)	T	Y	381		5.00E+01	2.00E-07	3.86E-07	3.98E+05	2.69E+04	3.31E+03
72-20-8	Endrin (ketone)	T	Y	381	1.65	2.60E-01	7.00E-07	5.00E-07	2.18E+05	8.32E+03	1.48E+03
100-41-4	Ethylbenzene	V	N	106	0.86	2.08E+02	7.08E+00	8.68E-03	1.41E+03	2.57E+02	3.72E+01
206-44-0	Fluoranthene	S	N	202	1.25	3.73E-01	5.00E-06	1.69E-02	1.66E+05	4.17E+04	1.15E+03
86-73-7	Fluorene	S	N	116	1.20	1.98E+00	7.10E-04	2.10E-04	2.40E+04	5.01E+03	1.29E+03
7782-41-4	Fluoride (and fluorine cmpds)	W	N	19	1.51	NA	NA	NA			
1024-57-3	Heptachlor epoxide	T	Y	389		3.50E-01	2.60E-06	3.20E-05	2.51E+05	2.09E+04	1.45E+04
193-39-5	Indeno(1,2,3-cd)pyrene	S	N	276		6.20E-02	1.00E-10	2.96E-20	5.01E+07	3.09E+07	5.01E+04
	Isodrin (see Aldrin)										
7439-92-1	Lead (and compounds)	M	N	207	11.34	NA	NA	NA		1.02E+04	4.90E+01
7439-96-5	Manganese (and compounds)	M	N	55	7.47	NA	NA	NA			
7439-97-6	Mercury (and compounds)	M	N	201	13.53	2.00E+03	2.00E-03	NA	5.13E+00	6.76E+01	5.50E+03
75-09-2	Methylene chloride	V	Y	85	1.33	1.94E+04	4.40E+02	2.69E-03	2.00E+01	8.71E+00	5.01E+00
91-57-6	Methylnaphthalene (2-)	S	N	142	1.01	2.54E+01	ND	2.90E-04	1.29E+04	8.51E+03	3.02E+02
106-44-5	Methylphenol (4-)	S	N	102	1.03	2.30E+04	1.20E-01	7.92E-07	1.02E+03	4.90E+01	1.74E+01
91-20-3	Naphthalene	S	N	128	1.16	4.00E+04	2.30E-01	1.22E-03	5.01E+04	3.31E+03	1.00E+03
7440-02-0	Nickel (and compounds)	M	N	59	8.90	NA	NA	NA			4.68E+01
	Nitrate/nitrite	W	N	62		NA	NA	NA			
85-01-8	Phenanthrene	S	N	178	1.18	1.29E+00	6.80E-04	2.56E-05	3.70E+04	3.89E+04	2.63E+03
108-95-2	Phenol	S	N	94	1.07	9.30E+04	3.40E-01	3.97E-07	3.02E+01	2.69E+01	1.41E+00
1336-36-3	Polychlorinated biphenyls (Aroclors)	F	Y	361	1.38	3.10E-02	7.70E-05	1.07E-03	2.19E+06	5.25E+05	1.00E+05
129-00-0	Pyrene	S	N	202	1.27	1.71E-01	2.50E-06	1.87E-05	2.09E+05	1.35E+05	4.57E+02

Table 2.2 (continued)
Relevant Physical and Chemical Properties
of Chemicals of Concern
Hamilton Army Airfield

CAS Number	Material Name	Analyt Class	Chlor (Y/N)	Mol Wt	Spec Grav	Solubility (mg/L) (1)	Vapor Pressure (mm Hg) (1)	Henry's Law K (atm-m3/mole) (1)	Kow (1)	Koc (1)	BCF (1)
7782-49-2	Selenium (and compounds)	M	N	79	4.28	4.00E-04	NA	NA			1.91E+01
7440-22-4	Silver (and compounds)	M	N	108	10.49	NA	NA	NA			3.09E+03
79-34-5	Tetrachloroethane (1,1,2,2-)	V	Y	168	1.59	2.97E+03	6.00E+00	4.56E-04	3.63E+02	1.17E+02	4.17E+01
	Tin	M	N	119	7.28	NA	NA	NA			
108-88-3	Toluene	V	N	92	0.86	6.27E+02	2.20E+01	6.74E-03	6.31E+02	1.51E+02	1.07E+01
88-06-2	Trichlorophenol (2,4,6-)	S	Y	197	1.49	9.00E+02	1.70E-02	9.07E-08	5.25E+03	1.07E+03	1.51E+02
7440-62-2	Vanadium (and compounds)	M	N	51	6.11	NA	NA	NA			
1330-20-7	Xylene (mixed isomers)	V	N	106	0.87	1.98E+02	1.00E+01	4.20E-03	1.51E+03	3.47E+02	1.58E+02
7440-66-6	Zinc (and compounds)	M	N	65	7.14	1.00E+01	NA	NA			4.68E+01

(1) Information gathered from Superfund Public Health Evaluation Manual -- EPA 540/1-86/060 [Supplemental information gathered from the Merck Index, Eleventh Edition; National Institute of Occupational Safety and Health -- Registry of Toxic Effects of Chemical Substances; Fate and Exposure Data, vol. 1-3 (Howard, et al, Lewis Publishers); Estimating Toxicity of Industrial Chemicals to Aquatic Organisms Using SARs, Volume I (USEPA 560/6-88-001); Envirofate Database (Chemical Information System)].

Abbreviations: Anlyt Class = general analytical classification; Chlor (Y/N) = chlorinated compound; Mol wt = molecular weight; Spec Grav = Specific gravity, F = biphenyl; M = metals; S = semi-volatiles; T = pesticides; V = volatiles; W = wet chemistry; Koc = organic carbon (soils) partitian coefficient; Kow = octanol/water partition coefficient; BCF = bioconcentration factor (fish); NA = not applicable

may be considered in determining the necessary level of cleanup for the protection of human health or the environment. The United States Environmental Protection Agency (EPA) has identified three categories of ARARs:

- Chemical-specific
- Location-specific (e.g., wetland limitation or historical sites) and
- Action-specific (e.g., performance and design standards)

Chemical-Specific Requirements

Chemical-specific requirements set health or risk-based concentration limits or methodologies in various environmental media for specific hazardous substances, pollutants, or contaminants. These requirements may set protective cleanup levels for the chemical in the designated media, or may indicate an acceptable level for discharges (e.g., air emission or wastewater discharge) when one occurs during a remedial activity.

The Hamilton Army Airfield Base Closure Property is not a National Priority List (NPL) listed site; however, the cleanup is proceeding following CERCLA guidelines. First, chemical-specific ARARs are addressed. Contaminated media at HAA include groundwater, surface water, soil and sediments. Potential ARARs at the federal level have been developed for groundwater and surface water only. A few state standards have been developed for soils and several potential ARARs are in draft form and not yet finalized.

Table 2.3 summarizes potential federal chemical-specific ARARs for this site, which include Safe Drinking Water Act (SDWA) MCLs and Maximum Contaminant Level Goals (MCLGs), and Federal Ambient Water Quality Criteria (WQC) for the protection of human health and freshwater aquatic life. Potential state chemical-specific ARARs are CalEPA MCLs (CalEPA MCLs may still be identified as former DHS MCLs in publications) and Applied Action Levels for surface water (saltwater). Appendix C provides a comparison of ARAR screening values and maximum concentration of contaminants found at each site. The applicability of state water quality goals depends on the beneficial uses for which the groundwater and surface water at the site must be protected. Beneficial uses are determined by the SFRWQCB. At this site, no beneficial uses have been determined. The groundwater is not considered recoverable as drinking water because the State of California Water Resources Control Board criteria for a potable groundwater source are not met. At HAA, total dissolved solids exceeds 3,000 mg/L in most wells and typical well yields are less less than 200 gallons per day. Thus, the groundwater beneath HAA has only limited beneficial uses due to high salinity, low yield, and high total dissolved solids (Goldsmith 1991).

The SFRWQCB recently determined that groundwater at HAA may have a beneficial use: replenishment of surface water in the perimeter drainage ditch which subsequently discharges to San Pablo Bay. The Final RI Report presents hydraulic conductivity data which supports the contention that groundwater discharges to the perimeter ditch are

Table 2.3
Potential ARARs for Chemicals of Concern
Hamilton Army Airfield

Chemical	FEDERAL							CALIFORNIA				
	WQC									Applied Action Levels		
	Human Health for the Consumption of Aquatic Organisms (µg/L)(d)	(Saltwater) Max (µg/L)	Continuous (µg/L)	SDWA(a,e) MCL(c) (mg/L)(d)	SDWA MCL (Proposed) (mg/L)	SDWA MCLG(b) (mg/L)	SDWA MCLG (Proposed) (mg/L)	California EPA(a) MCL (mg/L)	California EPA Action Level (mg/L)	Saltwater Species (µg/L)	Soil Contact (mg/kg)	LUFT(m) Manual Soil Criteria (mg/kg)
Acenaphthene	2,700											
Acenaphthylene	0.0311											
Aluminum								1				
Anthracene	0.0311										100	
Arsenic	0.14	69	36	0.05 (f)				0.05		20		
Barium				2 (i)	2 (i)	20 (i)	2 (i)	1				
Benzene	71			0.005 (h)		0 (i)		0.001		1		0.3 to 1
Beta-benzenehexachloride	0.046								0.0003			
Benzo(a)anthracene	0.0311				0.0001 (g,p)	0 (g,p)						
Benzo(a)pyrene	0.0311				0.0002 (g)	0 (g)						
Benzo(b)fluoranthene					0.0002 (g,p)	0 (g,p)						
Benzo(ghi)perylene	0.0311											
Benzo(k)fluoranthene	0.0311				0.0002 (g,p)	0 (g,p)						
Beryllium	0.131			0.004 (n)	0.001 (g,n)	0.004 (n)	0 (g,n)					
Bis(2-ethylhexyl)phthalate	5.9			0.006 (n)	0.004 (g,n)	0 (g,n)	0 (g,n)	0.004				
Boron												
Cadmium	170	43	9.3	0.005 (h)			0.005 (h)	0.01		5		
Chlorobenzene				0.1 (h,o)		0.1 (h,o)		0.03				
Chloroform	470			0.1 (h)				0.1 (q)				
Chromium (III)	670,000									2		
Chromium (VI)	3,400	1,100	50							2		
Chromium (Total)				0.1 (h,o)		0.1 (h,o)		0.05				
Chrysene	0.0311				0.0002 (g,p)		0 (g,p)					
Cobalt												
Copper		2.9	2.9	(l)		1.3 (h)	1.3 (j)			6		
Cyanide	215,000	1	1	0.2 (n)	0.2 (g,n)	0.2 (n)	0.2 (g,n)					
DDD	0.00083											
DDT	0.00059											
Dibenzo(a,h)anthracene	0.0311				0.0003 (g,p)		0 (g,p)					
Dibenzofuran												
cis-1,2 Dichloroethene				0.07 (h)		0.07 (h)		0.006				
trans-1,2 Dichloroethene				0.1 (h)		0.1 (h)		0.01				
Ethylbenzene	29,000			0.7 (h)			0.7 (h)	0.68				1 to 50
Fluoranthene	54											
Fluorene	0.031											
Fluoride				4 (k,o)		4 (o)						
Indeno([illegible]cd)pyrene	0.0311				0.0004 [illegible]	0 (g,p)						

Table 2.3 (continued)
Potential ARARs for Chemicals of Concern
Hamilton Army Airfield

Chemical	FEDERAL: WQC: Human Health for the Consumption of Aquatic Organisms ($\mu g/L$)(d)	FEDERAL: WQC: (Saltwater) Max ($\mu g/L$)	FEDERAL: WQC: Continuous ($\mu g/L$)	FEDERAL: SDWA(a,e) MCL(c) (mg/L)(d)	FEDERAL: SDWA MCL (Proposed) (mg/L)	FEDERAL: SDWA MCLG(b) (mg/L)	FEDERAL: SDWA MCLG (Proposed) (mg/L)	CALIFORNIA: California EPA(a) MCL (mg/L)	CALIFORNIA: California EPA Action Level (mg/L)	CALIFORNIA: Applied Action Levels: Saltwater Species ($\mu g/L$)	CALIFORNIA: Applied Action Levels: Soil Contact (mg/kg)	CALIFORNIA: LUFT(m) Manual Soil Criteria (mg/kg)
Lead		220	8.5	(l)		0 (h,o)	0 (j)	0.05		4		
Manganese												
Mercury	0.15	2.1	0.025	0.002 (o)		0.002 (h)		0.002				
Methylene chloride	1,600			0.005 (n)	0.005 (g,n)	0 (n)	0 (g,n)		0.04			
2-Methylnaphthalene												
4-Methylphenol												
Naphthalene										700		
Nickel	3,800	75	8.3	0.1 (n)	0.1 (g,n)	0.1 (n)	0.1 (g,n)			8		
Nitrate				10 (h,o)		10 (h,o)		45 (r)				
Phenanthrene											100	
Phenol	4,600											
Polychlorinated biphenyls (PCBs)	0.000045		0.03	0.5 (h)		0 (h)						
Pyrene	0.0311											
Selenium	6,800	300	71	0.05 (h,o)		0.05 (h,o)		0.01				
Silver		2.3						0.05		6		
1,1,2,2-Tetrachloroethane	11							0.001				
Toluene	300,000			1 (h,n)		1 (h,n)			0.1	20		0.3 to 50
TPH (gasoline)												10 to 1,000
TPH (diesel)												100 to 10,000
2,4,6-Trichlorophenol	3.6											
Vanadium												
m-Xylene												
Xylenes (mixed)				10 (h,o)		10 (h,i,o)		1.75 (s)		70	30,000	1 to 50
Zinc		95	86							10		

Notes:

(a) Primary levels (enforceable, health-based standards).
(b) MCLG = Maximum Contaminant Level Goal (nonenforceable).
(c) MCL = Maximum Contaminant Level (enforceable).
(d) $\mu g/L$ = micrograms per liter; mg/L = milligrams per liter.
(e) SDWA = Safe Drinking Water Act
(f) 40 CFR 1990 (per EPA Drinking Water Hotline 4/1/91).
(g) FR July 25, 1990, 55 FR 30370.
(h) FR January 30, 1991, 56 FR 3526.
(i) FR January 30, 1991, 56 FR 3600
(j) FR August 18, 1988, 53 FR 31516
(k) FR April 2, 1986, 51 FR 11396.
(l) Applied Action Level - Copper, 1.3 mg/L; Lead, 0.015 mg/L
(m) LUFT = Leaking Underground Fuel Tank; California State Water Resources Board, 1989
(n) FR Vol 57 No. 138 Friday, July 17, 1992
(o) 40 CFR Ch1 (7/1/1991 edition)
(p) Public comment is requested on establishing MCLGs at zero and MCLs at PQLs for six additional polynuclear aromatic hydrocarbons (PAHs) that are probable human carcinogens: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthrancene, and indenopyrene.
(q) Total trihalomethanes. Sum of bromodichloromethane, dibromochloromethane, bromoform and chloroform.
(r) Nitrate as NO3.
(s) Single isomer or sum of isomers.

Reference for Screening Values: Interim Guidance for Preparation of a Preliminary Endangerment Assessment Report. June 22,1990.

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intermittent and contribute only a minor component of surface flow. The closest surface water is the San Pablo Bay, and its existing and potential beneficial uses are as follows:

- Industrial service supply
- Navigation
- Commercial and sport fishing
- Contact and non-contact water recreation
- Wildlife and estuarine habitat
- Fish migration and spawning
- Preservation of rare and endangered species (SFRWQCB 1991)

According to the SFRWQCB Tentative Order for Landfill 26 (SFRWQCB 1991), existing and potential beneficial uses of groundwater in the general vicinity of the site include:

- Industrial service supply
- Domestic water supply

These uses are identified for Landfill 26 because pockets of freshwater have potentially been identified, but are unlikely to apply to the Base Closure Property because no beneficial uses have been identified there (Goldsmith 1991). If the groundwater is determined to be a potential source of domestic water, MCLs, non-zero MCLGs, and CalEPA MCLs would be potential ARARs. The POL area is the only area where groundwater samples meet the SFRWQCB criteria for freshwater. However, this water is both inaccessible (in rock) and also unlikely to produce sufficient yield to be classified as a potential drinking water aquifer. Groundwater from the POL area and from the Former Sewage Treatment Plant Area might affect surface water and thus be subject to standards to protect surface water. A mixing rule would probably apply to account for the attenuation and mixing of contaminants before and during discharge of groundwater to surface water. If groundwater is not protected for domestic use or protected as a potential source for surface water, there are no clear ARARs for the groundwater at the site. Reinjection of treated water was the favored alternative for treated water (Goldsmith 1991), but no adequate receiving aquifer was found. The favored alternative for Landfill 26 is discharge to wetlands, subject to a National Pollutant Discharge Elimination System (NPDES) permit approval.

The SDWA MCLs apply to "public water systems" and are defined as systems for the provision of piped water for human consumption with at least 15 service connections or serving at least 25 people (EPA 1988a). MCLs are based on allowable lifetime exposure in drinking water for an adult, but are also required to reflect technical and economic feasibility of removing the contaminant from the water supply. CalEPA MCLs are similar in derivation and application and are either the same as or more stringent than Federal MCLs.

The SDWA MCLGs are non-enforceable health goals for public water systems. MCLGs are set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety. Non-zero MCLGs are potentially relevant and appropriate standards for NPL sites under the NCP (EPA 1988a).

Federal WQC are non-enforceable guidelines used by states to set water quality standards for surface water. Federal WQC for specific pollutants should generally be identified as ARARs for surface-water cleanup if particular circumstances exist at the site that WQC were specifically designed to protect, unless the state has promulgated Water Quality Standards for the specific pollutants and water body at the site. For example, WQC for the protection of human health can be considered relevant and appropriate to surface waters designated by the State as a public water supply or for recreation. WQC for the protection of aquatic life may be found relevant and appropriate when protection of aquatic life is a concern. WQC are considered ARARs for groundwater only if groundwater is a current or potential source of drinking water, they reflect current scientific information and there are no Federal MCLs, non-zero MCLGs or state ARARs. If groundwater discharges into surface water, the groundwater remediation should be designed so that the receiving surface water body can meet any ambient water quality standards that may be ARARs for that surface water body (EPA, 1988a and 1990a).

Chemical-specific "To Be Considered" (TBC) criteria for chemicals of concern may or may not be utilized during the EI/AA process based on best professional judgment, presence of media- and chemical-specific ARARs, and site conditions. Some of the chemicals listed in Table 2.3 do not currently have an MCL or proposed MCL, but instead have published EPA Health Advisories. Health Advisories are not enforceable; however, these limits may be considered in determining risk to human health. Appendix H summarizes Health Advisory Limits for those chemicals of concern utilized in the human health risk assessment that do not have MCLs or proposed MCLs.

In summary, "To Be Considered" criteria at HAA includes, but is not limited to, the following:

- Proposed MCLs (Table 2.3)
- Proposed MCLGs (Table 2.3)
- Federal WQC human health for consumption of aquatic organisms (Table 2.3)
- Federal WQC saltwater maximum exposure limit (Table 2.3)
- Federal WQC saltwater continuous exposure limit (Table 2.3)
- Health Advisory Limits (Appendix H)
- Shallow Water Effluent Limits (Appendix I)
- PRGs (Table 2.4)
- Sediment screening criteria (Table 2.6)
- TPH remediation goals
- Preliminary Assessment Screening Values

The CalEPA (Formerly California DHS) published the Interim Guidance for Preparation of a Preliminary Endangerment Assessment Report in June 1990, which is designed to screen sites for public health impacts. The Preliminary Endangerment Assessment Report (DTSC 1990) which was used in the risk assessment for Hamilton Army Airfield has since been superceded by another guidance document (DTSC 1993). The new guidance does not provide chemical-specific screening values and differs from the June 1990 guidance in the methodology for conducting human health and ecological screening evaluations. The new guidance was not available at the time the risk assessment was conducted. However, the risk assessment (Section 5 of the Final EI Report, Engineering Science 1993) provides valuable conclusions regarding human health risk that were used to determine PRGs for human health (refer to Section 2.1.3). These PRGs were one set of criteria used in determining which sites require remediation.

Appendices in the Preliminary Endangerment Assessment Report (1990) include screening values to aid in the evaluation of potential public health impacts of groundwater, surface water, soil and air concentrations. In the context of this guidance, these values are used to determine whether a documented release of hazardous substances/wastes poses a significant threat to public health and requires further action if hazardous substances/wastes in these media exceed screening values or if those concentrations are determined to pose a threat to the environment. These screening levels are used both for single pathway and multi-pathway/multi-media exposures; i.e., even if the soil concentration of a chemical does not exceed its screening value, the sum of the ratios of all chemicals in all media of concern must not exceed one before the site is considered to have no impact. This is a similar methodology to the hazard index approach used to determine the non-carcinogenic effects of the site; however, this approach combines carcinogenic and non-carcinogenic endpoints.

TPH is present in some of the groundwater samples at HAA. Based on state water policies, groundwater quality at contaminated sites should be cleaned up to background concentrations, if feasible (Marshack 1992). The CRL for TPH in water is 100 μ/L which was used as the screening criteria to identify which sites require groundwater remediation.

Location-Specific Requirements

Potential location-specific ARARs for this site include critical habitat upon which endangered species or threatened species depend, fish and wildlife coordination act, wetlands, coastal zone management act, wilderness areas, and areas affecting a stream or river.

Representative receptor species were used in the EI as a practical alternative to evaluating risks to each of the species that potentially reside at the Hamilton. Factors considered in selecting receptor species included role in human and nonhuman food chains, abundance of the species, representativeness of biota occurring on site, and the availability of toxicological information to estimate contaminant risk. The terrestrial environmental receptors and the biological groups they represent include the following:

- Tall fescue - representing terrestrial flora

- House mouse - representing terrestrial small mammals
- Saltgrass - representing wetland (salt marsh) flora
- Mallard - representing wetland fauna

The toxicological effects of each of the contaminants retained for environmental analysis, such as lead, other metals, and TPH, on each of the receptor species was discussed in Section 5.2.7 in the EI. This information was then incorporated into the environmental risk assessment. Table F-1 in Appendix F presents a description of location-specific requirements and citations for them.

Action-Specific Requirements

Action-specific ARARs generally establish performance or design standards or limitations on particular actions used to mitigate the conditions on-site. The identified action-specific ARARs are used to establish minimum criteria for design or implementation of the proposed remedial action.

Several potential action-specific ARARs can be developed for the HAA sites. Action-specific ARARs address the planned remedial actions. Potential action-specific ARARs are presented in Table F-2 in Appendix F.

Action-specific ARARs can apply to the treatment technique itself or to its effect on the environment. ARARs applying to the treatment technique include chemical-specific standards which apply only at certain areas; for example, regulations regarding the disposal of pesticides and PCBs may be relevant and appropriate at some of the HAA sites.

The soil treatment alternatives also may have potential action-specific ARARs. Excavation could have Recsource, Conservation and Recovery Act (RCRA) requirements be deemed relevant and appropriate. Incineration of RCRA hazardous waste could be subject to various requirements including hazardous waste manifests, Department of Transportation (DOT) requirements and treatment facility screening requirements. Incineration of pesticides could be subject to other requirements. Many of the land treatment alternatives (e.g., bioremediation, soil venting) could be subject to federal and state standards for land treatment. Land disposal restrictions could be applicable to off-site disposal alternatives.

Action-specific that apply to the action's effect on the environment include anti-degradation policies and various discharge requirements. The Porter-Cologne Water Quality Act of 1970 is California's primary statute governing water quality and water pollution. The Porter-Cologne Act provides for the adoption of water quality control plans (Basin Plans). State Water Resources Control Board Resolution Number 68-16, the "Statement of Policy with Respect to Maintaining High Quality of Waters in California" or the "non-degradational policy" is a potential action-specific ARAR for the site. This policy seeks to maintain high water quality for "the maximum benefit of the people", i.e., using a cost/benefit analysis of high water quality versus economic and social cost to the State. Resolution 68-16 is "not a 'zero discharge' standard but rather a policy statement

that existing water quality be maintained when it is reasonable to do so." (SFWRCB 1986).

Discharges to surface water may be required to meet NPDES standards. These include discharge limitations, monitoring requirements, reporting requirements, and best management practices. For example, discharges from the pump station into the San Pablo Bay might be required to be under an NPDES permit if they aren't already.

Discharges to a POTW would be required to comply with any standards the POTW imposes in order to meet its NPDES permit. Specific prohibitions preclude the discharge of pollutants that:

- Create a fire or explosion hazard in the POTW
- Will cause corrosive structural change to POTW
- Obstruct flow resulting in interference
- Are discharged at a flow rate and/or concentration that will result in interference
- Increase the temperature of wastewater entering the treatment plant that would result in interference, but in no case raise the influent temperature above 104°F (40°C)
- Discharge must comply with local POTW pretreatment program, including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements

The SFRWQCB developed Shallow Water Effluent Limitations (SWELs) to provide protection to San Francisco Bay Basin. The SWELs could be used as additional evaluation criteria, but they are not considered as ARARs for groundwater cleanup in this alternative's assessment. SWELs are applicable for discharges of remediated groundwater and, therefore, are potential action-specific ARARs where treated groundwater is discharged to surface water. The SFRWQCB has requested that SWELs be included as TBC criteria. The complete list of SWELs is included in Appendix I.

Underground injection of treated groundwater also has a number of requirements which may be potential ARARs. Requirements include well construction, monitoring and operation. These are more specifically addressed in Table F-2 in Appendix F.

The State of California also has Proposition 65 Discharge Requirements that could potentially be relevant and appropriate for discharges to surface water; however, they are based on drinking water standards and are thus unlikely to be applied to the HAA sites.

Some soil ARARs may involve discharges to the air for which some National Emission Standards for Hazardous Air Pollutants (NESHAPS) standards could potentially be relevant and appropriate. There may also be local standards for soil aeration. These are not included in the preliminary screening.

2.1.3 Remediation Goals

As indicated in Table 2.3, there are very few ARARs associated with contaminants in soil and sediment at HAA. This subsection describes the development of PRGs and other cleanup goals for contaminants in soil, sediment, and groundwater.

Contaminant concentrations are screened against:

- ARAR-based guidelines
- Risk-based PRGs
- Background metal concentrations
- Lead cleanup level
- Baseline risk assessments
- Sediment screening criteria
- TPH remediations goals

Preliminary Remediation Goals

Risk Assessment Guidance for Superfund, Human Health Evaluation Manual: Volume I, Part B, provides guidelines for development of PRGs (EPA 1991a). The PRGs are initial clean-up goals that are protective of human health and environment and are used in the evaluation of remedial alternatives. The PRGs, as presented in the above document, are chemical-specific for specific medium and land use combinations. In this evaluation, the PRGs were developed for the Chemicals of Concern (COCs) detected in soil and sediments under residential land use assumption. The chemical-specific PRGs, thus developed, were, then, compared against the reasonable maximum concentration values of the COCs. In this evaluation, a 95 percent upper confidence limit on the arithmetic average of the detected concentrations of a given chemical was used as the reasonable maximum concentration value.

There are two general sources of the chemical-specific PRGs including: 1) concentrations based on ARARs; and 2) concentrations based on risk assessment. The ARARs, as discussed in Section 2.1.2, include concentration limits set by other environmental regulations. The second source for the PRGs is risk assessment or risk-based calculations using carcinogenic and/or noncarcinogenic toxicity values.

Applicable ARARs, were used directly as the ARAR-based PRGs. The available ARARs for soil, however, are extremely limited. In this evaluation, the chemical-specific California Applied Action Levels for soil were selected, when available, as the ARAR-based PRGs. The ARAR-based PRGs are summarized in Table 2.3.

Risk-based PRGs were calculated, using the following risk-based PRG equations for carcinogenic and noncarcinogenic effects under residential land use, presented in Chapter 3 of the guidance document:

Residential Soil - Carcinogenic Effects

$$\text{Risk-Based PRG} = \frac{\text{TR} \times \text{AT} \times 365\ \text{days/year}}{\text{SF}_o \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{IF}_{soil/adj}}$$

where:

Parameters	Definition (units)	Default Value
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_o	oral cancer slope factor ((mg/kg-day)-1)	chemical-specific
AT	average time (yr)	70 yr
EF	exposure frequency (days/yr)	350 days/yr
$IF_{soil/adj}$	age-adjusted ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day

Residential Soil - Noncarcinogenic Effects

$$\text{Risk-Based PRG} = \frac{\text{THI} \times \text{AT} \times 365 \text{ days/year}}{1\ RfD_o \times 10^{-6} \text{ kg/mg} \times \text{EF} \times IF_{soil/adj}}$$

where:

Parameters	Definition (units)	Default Value
THI	target hazard index (unitless)	1
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
AT	average time (yr)	30 yr (for non-carcinogens, equal to ED [which is incorporated in $IF_{soil/adj}$])
EF	exposure frequency (days/yr)	350 days/yr
$IF_{soil/adj}$	age-adjusted ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day

Toxicity values including slope factors (SFs) and reference doses (RfDs) for carcinogenic and noncarcinogenic effects, respectively, were obtained from the Integrated Risk Information System (IRIS). All standard default values were assumed applicable. Also, under residential land use, risk of the contaminant from soils was assumed to be due to direct ingestion of soil only.

Finally, both ARAR-based and risk-based PRGs were compared against the 95 percent upper confidence limits of the detected chemical concentrations. The results of the PRG comparison is in Appendix C. Table 2.4 is a summary of ARAR based and risk based PRGs for soil.

Table 2.4
Preliminary Remediation Goals (PRGs)
Hamilton Army Air Field

Chemical Name	Toxicity Information		Risk-based PRG for Soil (a)		ARAR-based PRG for Soil		Other Clean-up Goals	
	Carcinogenic (SF)	Noncarcinogenic (RFD)	Carcinogenic	Non-carcinogenic	Goal	ARAR Source	Goal	ARAR Source
ACENAPHTHENE		6.00E-02	NA	1.62E+04				
ACENAPHTHYLENE			NA	NA				
ALDRIN	4.90E-03	3.00E-05	1.31E+02	8.10E+00				
ALUMINUM (and aluminum cmpds)			NA	NA				
ANTHRACENE		3.00E-01	NA	8.10E+04	1.00E+02	(b)		
ARSENIC (and arsenic cmpds)	1.80E+00	3.00E-04	3.56E-01	8.10E+01				
BARIUM (and barium cmpds)		7.00E-02	NA	1.89E+04				
BENZENE	2.90E-02		2.21E+01	NA				
BENZO(A)ANTHRACENE			NA	NA				
BENZO(A)PYRENE	5.79E+00		1.11E-01	NA				
BENZO(B)FLUORANTHENE			NA	NA				
BENZO(G,H,I)PERYLENE			NA	NA				
BENZO(K)FLUORANTHENE			NA	NA				
BERYLLIUM (and beryllium cmpds)	4.30E+00	5.00E-03	1.49E-01	1.35E+03				
BHC (beta-)	1.80E+00		3.56E-01	NA				
BIS(2-ETHYLHEXYL)PHTHALATE	1.40E-02	2.00E-02	4.57E+01	5.40E+03				
BORON		9.00E-02	NA	2.43E+04				
CADMIUM (and cadmium cmpds)		5.00E-04	NA	1.35E+02				
CHLOROBENZENE			NA	NA				
CHLOROFORM	6.10E-03	1.00E-02	1.05E+02	2.70E+03				
CHROMIUM (and chromium cmpds)		5.00E-03	NA	1.35E+03				
CHRYSENE			NA	NA				
COBALT (and cobalt cmpds)			NA	NA				
COPPER (and copper cmpds)		4.00E-02	NA	1.08E+04				
CYANIDE (and cyanide cmpds)		2.00E-02	NA	5.40E+03				
DIBENZO(A,H)ANTHRACENE			NA	NA				
DIBENZOFURAN			NA	NA				

Table 2.4 (continued)
Preliminary Remediation Goals (PRGs)
Hamilton Army Air Field

Chemical Name	Toxicity Information		Risk-based PRG for Soil (a)		ARAR-based PRG for Soil		Other Clean-up Goals	
	Carcinogenic (SF)	Noncarcinogenic (RFD)	Carcinogenic	Non-carcinogenic	Goal	ARAR Source	Goal	ARAR Source
DI-N-BUTYLPHTHALATE		1.00E-01	NA	2.70E+04				
DDD (2,2-)	2.40E-01		2.67E+00	NA				
DDE (2,2-)	3.40E-01		1.88E+00	NA				
DDT(2,2-)	3.40E-01	5.00E-04	1.88E+00	1.35E+02				
DICHLOROETHENE (1,2-)		1.00E-02	NA	2.70E+03				
DIMETHYLBENZENE (1,3-) (e)		2.00E+00 (e)	NA	5.40E+05				
DIELDRIN	1.60E+01		4.00E-02	NA				
ENDRIN		3.00E-04	NA	8.10E+01				
ENDRIN KETONE			NA	NA				
ETHYLBENZENE		1.00E-01	NA	2.70E+04				
FLUORANTHENE		4.00E-02	NA	1.08E+04				
FLUORENE		4.00E-02	NA	1.08E+04				
HEPTACHLOR EPOXIDE	9.10E+00	1.30E-05	7.03E-02	3.51E+00				
INDENO(1,2,3-CD)PYRENE			NA	NA				
ISODRIN	4.90E-03	3.00E-05	1.31E+02	8.10E+00				
LEAD (and lead cmpds)			NA	NA			5.35E+02	(c)
MANGANESE (and manganese cmpds)		1.00E-01	NA	2.70E+04				
MERCURY (and mercury cmpds)		3.00E-04	NA	8.10E+01				
METHYLENE CHLORIDE	7.50E-03	6.00E-02	8.53E+01	1.62E+04				
METHYLNAPHTHALENE (2-)			NA	NA				
METHYLPHENOL (4-)		5.00E-02	NA	1.35E+04				
NAPHTHALENE		4.00E-02	NA	1.08E+04				
NICKEL (and nickel cmpds)		2.00E-02	NA	5.40E+03				
NITRATE		1.60E+00	NA	4.32E+05				
PCBs								
AROCLOR-1254	7.70E+00		8.31E-02	NA				
PHENANTHRENE			NA	NA	1.00E+02	(b)		
PHENOL		6.00E-01	NA	1.62E+05				

Table 2.4 (continued)
Preliminary Remediation Goals (PRGs)
Hamilton Army Air Field

Chemical Name	Toxicity Information		Risk-based PRG for Soil (a)		ARAR-based PRG for Soil		Other Clean-up Goals	
	Carcinogenic (SF)	Noncarcinogenic (RFD)	Carcinogenic	Non-carcinogenic	Goal	ARAR Source	Goal	ARAR Source
PROPYLBENZENE			NA	NA				
PYRENE		3.00E-02	NA	8.10E+03				
SELENIUM		5.00E-03	NA	1.35E+03				
SILVER (and silver cmpds)		5.00E-03	NA	1.35E+03				
TETRACHLOROETHANE (1,1,2,2-)	2.00E-01		3.20E+00	NA				
TIN		6.00E-01	NA	1.62E+05				
TOLUENE		2.00E-01	NA	5.40E+04				
TPH			NA	NA				
TRICHLOROPHENOL (2,4,6-)	1.10E-02		5.82E+01	NA				
VANADIUM (and vanadium cmpds)		7.00E-03	NA	1.89E+03				
XYLENES (mixed isomers)		2.00E+00	NA	5.40E+05	3.00E+04	(b)		
ZINC (and zinc cmpds)		2.00E-01	NA	5.40E+04				

Notes:

NA = Not Applicable; no toxicity information

(a) Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary Remediation Goals, (U.S. EPA, 1991).

(b) California Applied Action Levels for Soils, Department of Toxic Substances Control (DTSC) 1991.

(c) DTSC; Cal EPA, Guidlines for Site Characterizationand Multimedia Risk Assessment for Hazardous Substances Release Sites, Chapter 5, Volume &, interim Final, July 1992.

(d) Regional Water Quality Control Board case decision for HAA.

(e) 1,3-Dimethylbenzene is a xylene isomer.

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Background Metals Concentration

Metal contaminants of concern that remain after applying the ARARs, PRG, lead cleanup level and baseline risk assessment criteria above, and appear to be pervasive throughout HAA are then compared to background metal concentrations in soils. In order to establish background metal concentrations, samples were collected at areas of the base that are presumed to be unaffected. Background samples were classified as either typical of inland conditions (10 samples) or typical of wetland conditions (14 samples). The concentration of metals in wetland soils were significantly higher than in inland soils concentrations of background samples are presented in Appendix B. Four sample points at background location BK-SS-2 were deleted from the wetland group due to the proximity of contaminated area identified by the Corps of Engineers (Corps 1994).

The upper threshold limit for background data that follows a normal distribution can be calculated by the formula: UTL = AVG + (V STD) where AVG, STD, and K are the average, standard deviation and tolerance factor respectively (EPA 1989b). The arithmetic mean (average) and the standard deviation were calculated by assigning a value of one half the certified reporting limit (CRL) for that analyte for all analytes with non-detectable concentrations. The tolerance factor (K), set at the 95 percent confidence interval is 2.911 at both the inland and at the wetland sites (10 samples).

Tables 2.5a and 2.5b summarize the average, standard deviation and upper limit for inland and wetland samples. The upper limit values were used as the default cleanup goal for those analytes that have PRGs or other cleanup criteria that are less than background. For example, the PRGs for beryllium and arsenic are 0.149 mg/kg and 0.356 mg/kg respectively. Arsenic and beryllium are naturally occurring elements found throughout HAA. The PRG for beryllium exceeds both the inland (1.32 mg/kg) and wetland (2.41 mg/kg) upper limit concentrations. The upper limit concentrations for arsenic based on inland and wetland samples are 12.98 mg/kg and 15.59 mg/kg respectively which are also considerably higher than the PRG. The background levels for arsenic and beryllium at HAA are consistent with mean concentrations found in soils in the western United States. Cleanup levels for elements such as these are based on estimated background concentrations (upper limits) rather than on PRGs.

The cleanup goals for metals in groundwater MCLs and ARARs are discussed in Section 2.1.2.

Lead Cleanup Level

The Corps of Engineers conducted a leachate study using sediments from the drainage ditch at the Aircraft Maintenance and from the tidal wetlands at the Pump Station. The results of this study indicate that the mobility of lead and other key metals (excluding nickel) appear low.

The California EPA - Department of Toxic Substances Control (DTSC) has developed a methodology which predicts lead blood levels in adults and children following exposure to inorganic lead by different pathways (DTSC 1992). DTSC assumes that no adverse health effects are observed provided blood levels do not exceed 10 μg/dL in

Table 2.5a
Summary of Background Metal Concentrations
Inland Soils

Inland Soil Samples **10 Samples** **95% Upper Tolerance Limit (K = 2.911)**			
Analyte	Average	Standard Deviation	Upper Tolerance Limit
	concentrations in mg/kg		
Aluminum	42,500	8,813	68,154
Arsenic	5.99	2.40	12.98
Barium	78.33	24.05	148.33
Beryllium	0.48	0.29	1.32
Boron	19.84	11.28	52.67
Calcium	3,959	554	5,572
Chromium	107.55	23.58	176.19
Cobalt	15.14	2.59	22.69
Copper	37.54	8.26	61.58
Iron	52,420	9,946	81,373
Lead	17.02	8.80	42.64
Magnesium	12,372	2,313	19,104
Manganese	449	192	1,008
Mercury	0.07	0.09	0.33
Nickel	80.79	13.96	121.42
Potassium	4,829	1,023	7,807
Sodium	957	583	2,655
Vanadium	84.37	18.08	137.01
Zinc	90.41	10.07	119.73

Notes:
See Appendix B.
Remediation goal is based on background level when background upper tolerance limit exceeded the PRG value provided in Table 2.4.

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Table 2.5b
Summary of Background Metal Concentrations
Wetland Soils

Wetland Soil Samples
10 Samples
95% Upper Tolerance Limit (K = 2.911)

Analyte	Average	Standard Deviation	Upper Tolerance Limit
	concentrations in mg/kg		
Aluminum	65,510	13,316	104,272.88
Arsenic	9.71	2.25	16.26
Barium	145.70	55.56	307.44
Beryllium	0.89	0.58	2.57
Boron	57.87	16.14	104.85
Calcium	4,898	683	6,886.21
Chromium	144.00	19.04	199.43
Cobalt	21.06	3.37	30.87
Copper	72.86	8.75	98.33
Iron	59,810	6,722	79,377.74
Lead	37.77	8.26	61.81
Magnesium	18,040	1,769	23,189.56
Manganese	568	331	1,531.04
Mercury	0.45	0.10	0.74
Nickel	118.10	11.33	151.08
Potassium	8,341	2,322	15,100.34
Selenium	0.35	0.38	1.46
Sodium	16,110	1,801	21,352.71
Vanadium	120.99	22.44	186.31
Zinc	154.60	17.74	206.24

Notes:
See Appendix B.
Remediation goal is based on background level when background upper tolerance limit exceeded the PRG value provided in Table 2.4.

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children and fetuses, and 30 µg/dL in adults. These concentrations were used to back-calculate the maximum acceptable concentration of lead permissible in the soil and in the groundwater (see Appendix G). For soil a concentration of 535 mg/kg would result in a lead blood level of 10 mg/dL. Likewise, the maximum acceptable lead concentration in water is 710 mg/l. These cleanup goals have been applied to sites when considering the Development Option.

Baseline Risk Assessments

PRGs described above are chemical-specific goals; therefore site-specific exposure assumptions and future land use options can modify risk-based PRGs. To determine if contaminants of concern have to be added or dropped from the list, each contaminant's influence on total site risk was evaluated for each site with total risk (as calculated from the baseline risk assessment) greater than 1×10^{-4}. No contaminants of concern were added or dropped from the list, nor was it necessary to modify PRG values as a result of the comparison with the baseline risk assessment.

Sediment Screening Criteria

The SFRWQCB has developed proposed guidelines for disposal of sediments (SFRWQCB 1992b). Sediment disposal methods include:

1) Class I landfill;

2) Class II landfill;

3) Class III landfill;

4) wetlands creation where the sediment is not covered with clean fill; and,

5) applying clean fill as cover or top on sediments.

Table 2.6 summarizes the sediment disposal criteria and contaminants exceeding the criteria. Of the five sediment criteria, the most conservative is the wetlands creation assuming the sediment/soil does not require a protective cover (Method 4). The wetland cover criterion is used as remediation goal for screening contaminant concentrations for soils and sediments that will be inundated by water in the wetland option for future base use. The same criteria was also used to screen sediments (that are presently inundated by water) for the sale/Development Option. Table 2.6 includes the analytes listed in the SFRWQCB sediment screening criteria plus other analytes identified in the environmental risk assessment. Average contaminant concentration at each site were compared with the screening criteria.

The WET procedures conducted by the Army Corps of Engineers using sediments at HAA indicate that the mobility of key metals other than nickel appear to be low. The SFRWQCB has established additional criteria for nickel levels in soil/sediment assuming the wetland option is pursued. The screening level is set at 90 mg/kg above which three feet of cover material is needed. Nickel concentrations above 140 mg/kg require remediation.

Table 2.6
Summary of Contaminants Exceeding Sediment Screening Criteria Wetland Areas

Location	Analyte	Sediment Screening Criteria		Mean Concentration in Medium		Exceeded No-Cover Sediment Criteria		Exceeded Cover Sediment Criteria	
		Without (a) cover (mg/kg)	With (b) cover (mg/kg)	Soil (mg/kg)	Sediment (mg/kg)	Soil	Sediment	Soil	Sediment
POL Area	None	-	-	-	-	None	-	None	-
Burn Pit Area	None	-	-	-	-	None	-	None	-
Revetment Area	None	-	-	-	-	None	-	None	-
Fuel Lines	Lead	<50	50 - 110	66.5	-	Yes	-	No	-
Building 442 AST	None	-	-	-	-	None	-	None	-
East Levee Landfill	Lead	<50	50 - 110	52.4	-	Yes	-	No	-
Aircraft Maintenance	Benzo(A)anthracene	<0.230	0.230 - 1.600	-	0.525	-	Yes	-	No
	Fluoranthene	<0.600	0.600 - 3.600	-	3.21	-	Yes	-	No
	Phenanthrene	<0.225	0.225 - 1.380	-	3.90	-	Yes	-	Yes
	Pyrene	<0.350	0.350 - 2.200	-	3.75	-	Yes	-	Yes
	Total PAH (c)	<4	4 - 35	-	70.54	-	Yes	-	Yes
	Lead	<50	50 - 110	10	84	No	Yes	No	No
	Manganese	<500	>500	343	661	No	Yes	No	Yes
	Nickel	<140	140 - 200	30	149	No	Yes	No	No
	Zinc	<160	160 - 270	39	232	No	Yes	No	No
Former Sewage Treatment Plant	Mercury	<0.35	0.35 - 1.3	1.20	0.20	Yes	No	No	No
	Silver	<1.0	1.0 - 2.2	10.5	ND	Yes	No	Yes	No
	Dieldrin	<0.00002	0.00002 - 0.008	0.0105	-	Yes	-	Yes	-
	Endrin	<0.00002	0.00002 - 0.045	0.0099	-	Yes	-	No	-
	PPDDD	<0.002	0.002 - 0.02	0.504	-	Yes	-	Yes	-
	PPDDE	<0.002	0.002 - 0.015	0.0423	-	Yes	-	Yes	-
	PPDDT	<0.001	0.001 - 0.007	0.112	-	Yes	-	Yes	-

NOTES:

ND - Not detected

(shaded) Estimated sediment screening criteria not proposed by RWQCB, but included in the ecological risk assessment.

(a) Without - requires no protective covering for soil.

(b) With - requires protective covering for soil.

(c) Criteria compared to the total PAH concentrations from individual samples.

(d) TPH retained because of the excessively high concentration detected.

t2_6.wk1
05/09/94

Table 2.6 (continued)
Summary of Contaminants Exceeding Sediment Screening Criteria Wetland Areas

Location	Analyte	Sediment Screening Criteria		Mean Concentration in Medium		Exceeded No-Cover Sediment Criteria		Exceeded Cover Sediment Criteria	
		Without (a) cover (mg/kg)	With (b) cover (mg/kg)	Soil (mg/kg)	Sediment (mg/kg)	Soil	Sediment	Soil	Sediment
Pump Station	2-Methylnaphthalene	<0.065	0.065 - 0.670	12.02	-	Yes	-	Yes	-
	Acenaphthene	<0.150	0.150 - 0.650	0.744	-	Yes	-	Yes	-
	Benzo(A)anthracene	<0.230	0.230 - 1.600	3.38	0.107	Yes	No	Yes	No
	Benzo(A)pyrene	<0.400	0.400 - 2.500	1.22	-	Yes	-	No	-
	Chrysene	<0.400	0.400 - 2.800	4.9	0.148	Yes	No	Yes	No
	Dibenz(A,H)anthracene	<0.060	0.060 - 0.260	1.64	-	Yes	-	Yes	-
	Fluoranthene	<0.600	0.600 - 3.600	4.36	0.145	Yes	No	Yes	No
	Fluorene	<0.035	0.035 - 0.640	0.106	-	Yes	-	No	-
	Naphthalene	<0.340	0.340 - 2.100	4.43	-	Yes	-	Yes	-
	Phenanthrene	<0.225	0.225 - 1.380	18.41	0.152	Yes	No	Yes	No
	Pyrene	<0.350	0.350 - 2.200	4.83	0.271	Yes	No	Yes	No
	Total PAH (c)	<4	4 - 35	60.12	2.29	Yes	No	Yes	No
	TPH (d)	-	-	57,005	1,464	Yes	Yes	Yes	Yes
	Lead	<50	50 - 110	68.4	153.4	Yes	Yes	No	Yes
	Manganese	<500	>500	-	2,235	-	Yes	-	Yes
	Nickel	<140	140 - 200	-	192	-	Yes	-	No
	Silver	<1.0	1.0 - 2.2	-	1.0	-	No	-	No
	Zinc	<160	160 - 270	-	221	-	Yes	-	No
	PPDDD	<0.002	0.002 - 0.02	-	0.562	-	Yes	-	Yes
	PPDDT	<0.001	0.001 - 0.007	-	0.070	-	Yes	-	Yes

NOTES:

ND - Not detected

[shaded] Estimated sediment screening criteria not proposed by RWQCB, but developed by ES and applied in the ecological risk assessment.

(a) Without - requires no protective covering for soil.

(b) With - requires protective covering for soil.

(c) Criteria compared to the total PAH concentrations from individual samples.

(d) TPH retained because of the excessively high concentration detected.

t2_6.wk1
05/09/94

Total Petroleum Hydrocarbon Remediation Goal

There is no specific ARAR-based or risk-based remediation goal for TPHs. The Leaking Underground Fuel Tank (LUFT) Field Manual (SWRCB, 1989) provides a TPH cleanup range from 10 mg/Kg to 1,000 mg/Kg, depending principally on the components of TPH (i.e., jet fuel, diesel, etc.), the vertical distance from the contamination in the soil to groundwater, and the physical characteristics of the soil. The non-degradation policy of the SWRCB Resolution 92-49 directs the SFRWQCB to require cleanup and abatement in a manner that promotes attainment of background water quality or the highest water quality that is reasonable if background level of water quality can not be achieved. The SFRWQCB has indicated that the soil cleanup level at HAA will be 10 mg/Kg for the Land Sale/Development Option (B. Smith 1992). The cleanup level at HAA for the wetland option is 100 mg/Kg.

The 10 mg/kg TPH soil cleanup criteria is used for the Development Option for all the HAA sites with the exception of the POL Area. A TPH cleanup goal of 100 mg/kg is proposed for the POL Area because much the TPH contamination at the POL Area is found in rocks (approximately 75 percent of total volume). Contaminants trapped in rock fractures are relatively immobile and extremely difficult to remediate to a TPH concentration of 10 mg/kg. This is supported by recent remediation of TPH contaminated soils at the POL Area conducted by Environmental Health Research and Testing Inc. (EHRT) and International Technologies Corporation (IT) using chemical oxidation. Analysis of remediated soils showed residual TPH to be well above 10 mg/kg (IT 1991). Furthermore, a 100 mg/kg TPH cleanup criteria is also supported by the California LUFT Manual for the site conditions at the POL Area. Finally, the TPH contaminants are of heavy fractions close to diesel fuel as corroborated by sampling results that show no BTEX detected in the soil.

For the Wetland Option, a 100 mg/kg TPH cleanup goal is used for the HAA sites. Soil or sediment containing TPH between 10 mg/kg and 100 mg/kg would be covered with 3 feet of fill creating a non-engineered cap. This cleanup goal (100 mg/kg) is derived from sediment characterization data compiled from dredged material disposal documentation (Public Notices) for the northern San Francisco Bay provided by the U.S. San Francisco District Army Corps of Engineers. The public notices indicate that typical recoverable TPH concentration in sediment ranged from 3 to 46 mg/kg, with some isolated cases showing TPH as high as 250 mg/kg TPH. Based on this information, a 100 mg/kg TPH cleanup goal for the wetland option would be sufficient to bring the average TPH concentration in soils to less than 40 mg/kg. The average TPH concentration was estimated based on the assumption that if soils at HAA were remediated to 100 mg/kg, TPH and the HAA base is inundated with water, the average TPH concentration is the sum of all TPH analytical results from Appendix A (substitute 100 mg/kg for concentrations above 100 mg/kg and CRL value for non-detects) divided by the total number of soil samples. This estimate is extremely conservative because soil samples were collected only in areas of suspected contamination.

The cleanup goal for TPH in groundwater has been set at 50 mg/L. However, the detection limit in the EI was 100 µg/L. A lower detection limit will be used in monitoring sites.

VOCs and SVOCs

Generic soil cleanup goals for total volatile organic compounds (VOCs) and total semi-volatile organic compounds (SVOCs) are identified in the SFRWQCB's Proposed Groundwater Amendment To The Water Quality Control Plan, for the San Francisco Bay Region (SFRWQCB 1993). Several SFRWQCB Orders, adopted primarily for Superfund sites, include cleanup standards of 1 mg/kg for total volatile organic compounds (VOCs) and 10 mg/kg total semi-volatile organic compounds (SVOCs), as identified by EPA Methods 8240 and 8270, respectively. This generic cleanup standard is based on the modeling results at a Superfund site in the region, the existence of similar standards in New Jersey and the professional judgment of the SFRWQCB staff (SFRWQCB 1993). These generic cleanup goals for total VOCs and SVOCs are not used for HAA because:

- These generic cleanup goals are in proposal stage (in public hearing phase during development of the AA)
- Generic total VOCs and SVOCs cleanup goals were not identified as potential cleanup goals during meeting with SFRWQCB
- And HAA is already utilizing risk-based and ARAR-based PRGs for individual chemicals

The cleanup goal for groundwater includes MCLs and ARAR, discussed in Section 2.1.2.

PCBs in Oil-filled Devices

Transformers or other devices containing PCBs can continue to remain in service. However, once removed from service, disposal must be conducted in accordance with TSLA regulations 40 CFR 761 Subpart D. With few exceptions, PCB at concentrations of 50 ppm or greater must be treated in an incinerator that complies with 40 CFR 761.70. If the appliance or oil containing 50 ppm or greater PCB is stored prior to disposal, the storage facility must comply with 40 CFR 761.65. The applicance or container of PCB can be stored for up to one year from the date it was first put into storage. The area must be inspected for leaks every 30 days if stored inside. and weekly if stored outside.

2.2 GENERAL RESPONSE ACTION

The baseline public health and environmental risk assessments conducted as part of the EI examined exposure pathways, maximum contaminant concentrations (in the absence of remedial action), and resultant risks. A brief summary of the risk assessments is provided in Section 1.2.5. Under worst-case scenarios, risk to public health and environment was not at a level to require immediate response action. To meet the objectives above, long-term general response actions were developed to address the areas

of concern for soils and groundwater. Remedial technologies in five general response actions categories to be evaluated in this report include:

- Containment
- In-situ treatment
- Extraction or excavation
- Treatment
- Disposal

Remedial actions which are permanent, reduce contaminant mobility, toxicity, or volume and employ on-site treatment area preferred. The recommended remedial actions will combine these criteria to achieve the primary objectives in a cost-effective manner.

The types of contaminants exceeding PRGs or other cleanup goals for soil sediment or groundwater at each site are presented in Table 2.7.

Soils

As shown in Table 2.7, contaminants that exceeded PRG or other cleanup levels in soils assuming the Development Option include: TPH, DDD, benzo[a]pyrene, beta-benzenehexachloride, PCBs, beryllium, lead and arsenic.

Based on these remediation goals, the estimated volume of soils to be remediated at each site for the Development Option is presented in Table 2.8a. The total volume of contaminated soil and rock which exceeded a cleanup criteria is 250,000 cubic yards. Of the 250,000 cubic yards, approximately 15,000 cubic yards, or 6 percent, represent rock, which exceeded the cleanup goal.

Table 2.8a also lists sediments that exceed the sediment screening criteria and requires remediation. This sediment volume is included in the total for soils because they will require remediation for either the Wetland or the Development Option. Approximately 24,450 cubic yards of sediment require remediation and 36,660 cubic yards of cover material on the sediments is needed. The Aircraft Maintenance Area contains beryllium throughout the site that exceeds the PRG (0.149 mg/kg) and the background concentration of the native Bay Mud (1.32 mg/kg). One alternative is to cover the areas not already capped by concrete or asphalt. The volume of cover material at the Aircraft Maintenance Area is 68,600 cubic yards.

Sediments

Table 2.6 shows the contaminants that exceeded sediment cleanup goals and Table 2.8b shows the estimated volumes. Sediment cleanup goals and the SFRWQCB's nickel screening level were exceeded primarily at two sites: the Pump Station and the Aircraft Maintenance and Storage Area. The Pump Station soil and sediments have been assigned to Operable Unit 2. Additional investigations will be conducted to further characterize

TABLE 2.7

SUMMARY OF CONTAMINANTS EXCEEDING PRGs OR OTHER CLEANUP GOALS HAMILTON ARMY AIRFIELD

Site	Media	Contaminants Detected: Exceeded PRG [1,2] or Other Cleanup Goals	Contaminants Detected: Did Not exceed PRG [1,2] or Other Cleanup Goals
Site 1 POL Area	Soil	TPH	VOCs, SVOCs, lead
	Groundwater	TPH, benzene bis(2-ethylhexyl) phthalate	other VOCs, SVOCs, lead
Site 2 Burn Pit			
• Beneath Pad	Soil	TPH	VOCs, SVOCs, lead
• Perimeter of Pad	Soil	TPH	toluene, SVOCs, lead
	Groundwater	TPH	VOCs, lead
Site 3 Revetment			
• Revetment Pads	Soil	TPH	SVOCs, lead
• Engine Test Pad	Soil	TPH	toluene, SVOCs, lead
	Groundwater	Manganese	metals, cyanide
Site 4 Pump Station			
• AST Site	Soil	TPH, benzo[a]pyrene, beta-benzenehexachloride lead	VOCs, other SVOCs,
• Stockpile	Soil	TPH	VOCs, SVOCs, lead
• Sediments	Sediments	TPH, DDD, beryllium, lead	other SVOCs, other metals
	Groundwater	Manganese	VOCs, metals, cyanide
Site 5 Former Sewage Treatment Plant	Soil	TPH, PCB	toluene, SVOCs, metals cyanide, other pesticides
	Sediment	None	metals, cyanide
	Groundwater	Benzene, antimony chloride, 1,4 Dichloro-benzene phenol	other VOCs, SVOCs, metals

TABLE 2.7 (continued)

Site	Media	Contaminants Detected: Exceeded PRG [1,2] or Other Cleanup Goals	Contaminants Detected: Did Not exceed PRG [1,2] or Other Cleanup Goals
Site 6 East Levee Landfill	Soil	None	SVOCs, metals
	Groundwater	Chloride, Manganese	VOCs, SVOCs, metals, cyanide
Site 7 Aircraft Maintenance and Storage Area	Soil	TPH, arsenic, beryllium	VOCs, SVOCs, other, metals, cyanide[3]
	Sediment	TPH, benzo[a] pyrene, lead, beryllium, arsenic	other VOCs, other SVOCs other metals
	Groundwater	Benzene, beryllium, chromium, manganese	VOCs, SVOCs, metals,
Site 8 Fuel Lines	Soil	TPH	--
Site 9 Building 442	Soil	None	lead
Site 10 Transformers and Other Filled Items	--	NA	NA

NA = Not Applicable

Notes:

1 PRG - Preliminary Remediation Goals or other cleanup goals for contaminants in soils or sediments are as follows:
TPH - 10 mg/kg (SFRWQCB cleanup criteria; Development Option)
Lead - 535 mg/kg (calculated cleanup goal using DTSC Guidance)
Beta Benzenehexachloride > PRG (0.356 mg/kg)
Benzo[A]pyrene > PRG (0.111 mg/kg)
DDD - PRG (2.67 mg/kg)
PCB - PRG (0.0831 mg/kg)
As - PRG 0.356 mg/kg and background levels (inland soil 12.98 mg/kg, wetland soil 16.26 mg/kg)
Be - PRG (0.149 mg/kg) and background (inland soil 1.32 mg/kg; wetland soil 2.57 mg/kg)

2 PRG - Preliminary Remediation Goals for contaminants in surface water and groundwater are detailed in Table 2.9:
TPH - 100 mg/l (CRL)
Benzene - 0.001 mg/l (CalEPA MCL)

3 PRGs are identified for specific chemicals, therefore "Tentatively Identified Compounds" TICs are not included in this table.

Table 2.8a
Estimated Soil Volumes with TPH > 10 mg/kg and Other Contaminants[a]
Hamilton Army Airfield - Development Option

Area	Subarea Description	Dimensions (b) n	d	w_1	w_2	l	r_1	r_2	Volume (c) (ft^3)	(yd^3)
POL	Area A (soil) (TPH > 100 mg/kg)		7	100		200			140,000	
	Area A (rock) (TPH > 100 mg/kg)		13	100		200			260,000	
	Area B (rock) (TPH > 100 mg/kg)		20	40		160			128,000	
	Area C (rock) (TPH > 100 mg/kg)		20				20		25,130	
	Total volume for area								553,130	20,490
Burn Pit	Contaminated soil beneath pad to g.w. depth		8				60		90,480	
	Annular ring around burn pit		11				60	75	69,980	
	Total volume for area								160,460	5,940
Revetment Area	Pad 17 Annular ring		10				50	150	628,320	
	Pad 26 rectangle		2	90	190				34,200	
	Pad 27		4				70		61,580	
	Unpaved turnouts 9, 11, 12, 23, 29	5	4	140		190			532,000	
	Annular ring around other revetment pads	17	4				50	70	512,710	
	Engine Test Pad, annular half-ring	0.5	4				100	110	13,190	
	Total volume for area								1,782,000	66,000
Pump Station	AST-5		2	40		60			4,800	180
	AST-6 (TPH, SVOCs)		2	30		80			4,800	180
	AST-7 (TPH, metals)		2	50		80			8,000	300
	Soil stockpile adj. Bldg. 41		2				25		3,930	150
	USTs and piping NW Bldg. 41		10		30	50			15,000	560
	Sediments (TPH, metals, SVOCs)		2	200		1,500			600,000	22,220
	Cover material (d)		3	200		1,500			900,000	33,330
	Total volume for area								636,530	23,580
Former Sewage Treatment Plant	Drying beds (TPH, PCBs, pesticides, mercury)		2	90		180			32,400	1,200
	Cover material (d)		2	90		180			32,400	1,200
	Total volume for area								32,400	1,200
EL Landfill	Tidal wetland		2	150		450			135,000	5,000
	Total volume for area								135,000	5,000
Aircraft Maintenance Area	Soil - Storage Area 2 (TPH, metals)		5	50		200			50,000	1,850
	Soil - Storage Area 4: (TPH, metals)									
	East of Bldg 87		5	15		30			2,250	80
	West of Bldg 87		5				4		250	10
	Soil - Storage Area 3 (arsenic, beryllium)		5				8		1,010	40
	Other contaminated soil (beryllium)		2			site remainder			3,990,180	147,780
	Cover material South of Bldg 86 (d)								1,852,300	68,600
	Sediment - drainage system sumps (TPH, SVOCs, metals)	16	2	3		3			290	10
	Sediment - Drainage Channel (TPH, metals)		2	10		3,000			60,000	2,220
	Cover material drainage channel (d)		3	10		3,000			90,000	3,330
	Total volume for area								4,101,720	151,920
Fuel Lines	6" fuel line		4	5		1,800			36,000	
	JP-4 fuel line		4	5		2,500			50,000	
	Total volume for area								86,000	3,190
TOTAL SOIL									7,074,110	262,000
TOTAL ROCK									413,130	15,300
TOTAL SOIL AND ROCK									7,487,240	277,310
TOTAL COVER MATERIAL									2,874,700	106,470

Notes:

(a) subarea volumes contaminated with TPH > 10 mg/kg unless otherwise noted

(b) n=number of locations; d=depth; w_1/w_2=widths of area; l= length of area; r_1 = inner radius; r_2 = outer radius (all dimensions given in feet)

(c) volumes listed in yd^3 only for area totals unless other contaminants were found

(d) cover material consists of material that meets SF RWQCB criteria

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05/04/94

Table 2.8b
Estimated Soil Volumes with TPH and Other Contaminants[a]
Hamilton Army Airfield – Wetland Option

Area	Subarea Description	Dimensions (b)							Volume (		
		n	d	w_1	w_2	l	r_1	r_2	(ft^3)	(ft^3)	(yd^3)
POL	Area A (soil) (TPH > 100 mg/kg)		7	100		200			140,000	140,000	
	Area A (rock) (TPH > 100 mg/kg)		13	100		200			260,000	260,000	
	Area B (rock) (TPH > 100 mg/kg)		20	40		160			128,000	128,000	
	Area C (Rock) (TPH > 100 mg/kg)		20				20		25,133	25,130	
	Total excavation volume for area								553,133	553,130	20,490
Burn Pit	Contaminated soil beneath pad to g.w. depth		8				60		90,478	90,480	
	Area near BP-SS-5		3				10		942	940	
	Cover Material (e)		3				75		53,014	53,010	1,960
	Total excavation volume for area								91,420	91,420	3,390
Revetment Area	Annular ring around Pad 17		10				50	100	235,619	235,620	
	Cover Material (e)		3				150		212,058	212,060	
	Annular ring around Pad 20		4				50	70	30,159	30,160	
	Cover Material (e)		3				90		76,341	76,340	
	Pad 26 rectangle		2	50		150	50		30,708	30,710	
	Cover Material (e)		3	90		190			51,300	51,300	
	Pad 27		4				50		31,416	31,420	
	Cover Material (e)		3				70		46,181	46,180	
	Unpaved turnouts 9, 11, 12, 23, 29	5	4	100		150			300,000	300,000	
	Cover Material (e)	5	3	140		190			399,000	399,000	
	Cover Material over other revetment pads (e)	16	3				90		1,221,451	1,221,450	
	Engine Test Pad, annular quarter-ring	0.25	4				100	110	6,597	6,600	
	Cover Material for engine test pad (e)	0.5	3					130	79,639	79,640	
	Total excavation volume for Revetment area								634,500	634,500	23,500
	Total volume of Cover Material for Revetment Area								2,085,970	2,085,970	77,260
Pump Station	AST-5		2	30		50			3,000	3,000	110
	Cover Material (e)		3	40		60			7,200	7,200	270
	AST-6 (TPH, PAHs)		2	30		70			4,200	4,200	160
	Cover Material (e)		3	30		80			7,200	7,200	270
	AST-7 (TPH, Zinc)		2	40		70			5,600	5,600	[illegible]
	Cover Material (e)		3	50		80			12,000	12,000	[illegible]
	Soil stockpile adj. Bldg. 41		2				25		3,927	3,930	
	USTs and piping NW Bldg. 41		10		30	50			15,000	15,000	700
	Cover Material (e)		3		30	50	25		10,390	10,390	380
	Sediments (TPH, PAHs, pesticides, metals)		2	200		1,500			600,000	600,000	22,220
	Cover Material (d,e)		3	200		1,500			900,000	900,000	33,330
	Total excavation volume for Pump Station								631,727	631,730	23,400
Former Sewage Treatment Plant	Drying beds (TPH, PCBs, pesticides, metals)		2	90		180			32,400	32,400	1,200
	Cover Material (d,e)		3	90		180	20		52,370	52,370	1,940
EL Landfill	Tidal Wetland	2	3				20		7,540	7,540	280
	Tidal wetland cover material (e)		3	150		450			202,500	202,500	7,500
Aircraft Maintenance Area	Soil – Storage Area 2 (TPH, metals)		5	50		70			17,500	17,500	
	Soil – Storage Area 4: East of Bldg 87 (TPH, metals)		3				5		236	240	660
	Cover Material (d)								1,852,300	1,852,300	68,600
	Sediment – drainage system sumps (TPH, SVOCs, metals)	16	2	3		3			288	290	10
	Sediment – Drainage Channel (TPH, Be)		2	10		3,000			60,000	60,000	2,220
	Cover Material (d,e)		3	10		3,000			90,000	90,000	3,330
	Total excavation volume for area								78,024	78,020	2,890
Fuel Lines	6" fuel line (TPH and lead)		2	5		1,800			18,000	18,000	670
	6" and JP-4 fuel lines cover material (e)		3	5		3,300			49,500	49,500	1,830
AREA TOTAL (excluding cover and POL area)									1,493,611	1,493,610	55,320
COVER TOTAL									5,285,655	5,285,650	195,760

Notes:

(a) Estimated soil excavation and cover volumes for areas where TPH > 100 mg/kg and/or where contaminants are identified by the ecological risk or sediments screening criteria

(b) n=number of locations; d=depth; w_1/w_2=widths of area; l=length of area; r_1=inner radius; r_2=outer radius; (all dimensions given in feet)

(c) volumes listed in yd^3 only for area totals unless other contaminants were found

(d) Cover material applied where contaminant above sediment screening criteria or other criteria

(e) Cover material applied to areas where TPH is above 10 mg/kg.

[shaded box] : – shaded areas signify cover material figures; unshaded areas reflect excavation figures.

the site. The contaminated sediments found in the Aircraft Maintenance and Storage Area were located within the concrete-lined storm drain system. The sediments in the concrete vaults are included in Operable Unit 1. However, the sediments in the drainage channel are part of Operable Unit 2 and an additional investigation will be conducted.

Soils will be inundated, if the Wetland Option is selected. Soils that exceed the sediment screening criteria, include East Levee Landfill (OU1), Fuel Lines (OU1 and OU2), Pump Station (OU2), and FSTP (OU1). Two soil samples at Aircraft Maintenance (OU1) exceed the SFRWQCB's nickel screening value of 90 mg/kg and require cover material be applied. Soil at the Burn Pit (OU1) and at the Revetment Area (OU1) exceed 100 mg/kg TPH.

Sediment samples are shallow samples. In order to estimate the volume of sediment (soil and sediment if Wetland Option) that exceeded the sediment screening criteria (with cover), it is assumed that the top 2 feet of sediment contaminated at levels that exceed the with-cover criteria would be excavated and treated. A total of 3 feet of cover material would be applied. The treated sediment could make up part of the sediment cover.

For the Wetland Option, the estimated volume of contaminated soils and sediments exceeding cleanup goals for each site is presented in Table 2.8b. The total volume of soil which exceeded a cleanup criterion is 55,000 cubic yards. Approximately 107,200 cubic yards of cover material are needed on areas containing non-TPH contaminants. Approximately 88,550 cubic yards of material will be applied to areas where TPH exceeds 10 mg/kg and which complies with sediment screening criteria and the SFRWQCB's screening criteria for nickel.

Groundwater

Table 2.9 shows contaminants that exceeded Federal or California MCLs. Groundwater from the POL Area, Former Sewage Treatment Plant and Aircraft Maintenance Area exceeded MCLs for benzene and other organics. TPH concentration in groundwater at the POL Area and the Burn Pit also exceeded the certified reporting limit for TPH of 100 μg/L. The Former Sewage Treatment Plant and the Aircraft Maintenance Area also has metals exceeding MCLs.

2.3 IDENTIFICATION OF TECHNOLOGIES

General response actions identified for soil and groundwater remediation at HAA include containment, in-situ treatment, extraction or excavation, treatment, and disposal. Possible technologies for remediation for the five general remedial action categories are listed in Table 2.10. Section 2.4 provides a brief description of each technology and screens each technology for further evaluation.

2.4 SCREENING OF REMEDIAL TECHNOLOGIES

The purpose of this section is to screen potentially applicable technologies and process options and to eliminate those that are not appropriate to site-specific problems. This screening step assesses each technology based on two general screening criteria: waste-limiting and site-limiting characteristics. Waste-limiting characteristics consider effectiveness of technologies on contaminant types and physical and chemical properties

TABLE 2.9

GROUNDWATER AND SURFACE WATER CONTAMINANTS EXCEEDING POTENTIAL ARARS

Hamilton Army Airfield

Site/Analyte	Max Conc µg/L	Federal MCL µg/L	CA MCL µg/L	CRL(3) µg/L
POL				
Benzene	9.69	5	1	
Bis (2-ethylhexyl)-phthalate	29.3	6	4	
TPH	14,000			100
BURN PIT				
TPH	140			100
REVETMENT				
Manganese	1,050		50(4)	
PUMP STATION (Groundwater)				
Manganese	4,360		50(4)	
PUMP STATION (Surface Water)				
Manganese	2,130		50(4)	
Chloride	13,000,000		250,000(4)	
FSTP				
Antimony	101	6	--	
Benzene	1.24	5	1	
Chloride	18,000,000	--	250,000(4)	
1,4-Dichlorobenzene	15	75	5	
Phenol	232		5(1)	
EAST LEVEE LANDFILL				
Manganese	20,000,000		50(4)	
Chloride	6,620		250,000(4)	
AIRCRAFT MAINTENANCE				
Benzene	1.16	5	1	
Beryllium	20	4	--	
Chromium	52.4	100	50(2)	

(1) California Action Limit
(2) Assumes Cr VI
(3) CRL is the certified reporting limit.
(4) Secondary MCL

TABLE 2.10

GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES HAMILTON ARMY AIRFIELD

General Response Actions	Remedial Technologies
SOILS	
Containment	Capping Solidification/Stabilization Vitrification
In-Situ Treatment	Soil Vapor Extraction Bioremediation Bioventing Precipitation Soil Flushing Oxidation/Reduction
Excavation	Excavation Temporary Storage Waste Piles
Direct Treatment	Thermal Destruction Solidification/Stabilization Biological Treatment Low Temperature Thermal Desorption Chemical Oxidation Soil Washing
Disposal	Landfill (off-site) On-site Disposal
GROUNDWATER	
Containment	Subsurface Drains Subsurface Barriers Grading Capping

TABLE 2.10 (continued)

General Response Actions	Remedial Technologies
In-situ Treatment	Hydrolysis Polymerization Chemical Dechlorination Permeable Treatment Beds Biostimulation Air Sparging
Extraction	Groundwater Pumping
Direct Treatment	Off-site Treatment Flocculation/Precipitation Sedimentation Filtration Air Stripping Steam Stripping Steam Distillation Activated Carbon Adsorption Biological Treatment Ion Exchange and Reverse Osmosis Ultraviolet (UV)/Oxidation Liquid/Liquid Extraction Dissolved Air Flotation Oil/Water Separation Hydrolysis Chemical Dechlorination Oxidation/Reduction Aerated Lagoons Stabilization Ponds
Disposal/Discharge	Surface Water Discharge Alluvial Groundwater Recharge Surface Impoundment Deep Well Injection POTW Discharge

of compounds. Site-limiting characteristics consider site specific features such as topography, buildings, underground utilities, available space and proximity to sensitive operations on the implementability of technologies. During this screening step, process options and entire technology types are eliminated from further consideration if they cannot be physically or technically implemented. Retained technologies are then combined to form remedial action alternatives as discussed Section 3 of this report.

2.4.1 Soil Remedial Technologies

The candidate technologies which may be used to remediate soils at HAA are listed in Table 2.11. Retained technologies are identified for later inclusion in remedial alternatives. Rejected technologies are identified and reasons are given for rejection. This section briefly describes the applicable technologies and relates important contaminant site characteristics that may influence implementation of a technology.

2.4.1.1 Retained Technologies

Containment: Capping. Capping involves the placement of a low permeability barrier over the top of contaminated materials to prevent contact by possible receptors including humans and wildlife. Capping is also used to limit infiltration of precipitation through contaminated areas. This technology was retained since containment capping already exists for some areas of contamination, some areas of concern are relatively small, and capping could be used along with other technologies.

A variation of the capping technology includes covering the contaminated area with 3 feet of non-engineered fill. This variation was retained as a means of complying with the sediment screening criteria and a means to provide a substrate on which new plant life can take root. It is also considered for soils (in the Development Option) to prevent contact by potential receptors. However, cover material will not limit infiltration through contaminated areas.

In-situ Treatment: Soil Flushing. This technology involves introducing water or an aqueous solution containing surfactants, acids, or bases into the soil and extracting the contaminants. The elutriate is then collected and pumped to the surface and treated. This technology is more suitable for permeable soils, but additional injection and extraction points could improve remediation time for less permeable soils.

In-situ Treatment: Soil Vapor Extraction. Soil vapor extraction (SVE) involves drawing air through the contaminated soils in order to strip organics from the soil. The effectiveness of soil vapor extraction depends on contaminant volatility, contaminant partitioning from the soil, and the permeability of the subsurface. Vapor extraction has been used successfully for TPH contaminated sites. Technology is more suitable for permeable soils, but the use of more vapor extraction wells could improve remediation for less permeable soils. Works best on highly volatile compounds such as gasoline.

In-situ Treatment: *Thermally Enhanced Soil Venting.* One emerging class of thermal treatment technologies with potential application at HAA is in-situ heating methods such as radio frequency heating and thermally enhanced soil vapor extraction. Radio frequency heating uses electromagnetic energy similar to a microwave to heat soils in excess of 200 degrees Celsius and to rapidly volatilize organic contamination. Steam

TABLE 2.11

PRELIMINARY SCREENING OF SOIL REMEDIAL TECHNOLOGIES

Remedial Action Category	Technology	Retain	Reject	Description	Comments
CONTAINMENT	Capping	X		A low permeability barrier is placed over the contaminated materials or apply three feet of non-engineered fill over contaminated area.	Prevents direct contact with waste materials and minimizes leaching of contaminants to groundwater. Cover material provides a substrate for plant life and protects from potential receptors.
	Solidification/ Stabilization		X	Injection of binding materials to stabilize materials	More suitable to sludges in lagoons
	Vitrification		X	High temperature generated by electrodes to convert soil to glass-like material.	Amenable to treatment of heavy metals in silty clay soils. moisture contact in soil makes operating cost very high.
IN-SITU TREATMENT	Soil Flushing	X		The pumping of water or a solution of surfactants into the soil to mobilize contaminants. Elutriate is pumped to surface for reinjection or treatment.	May shorten time required for groundwater remediation, but the technique is more suitable for highly permeable soils
	Soil Vapor Extraction	X		Vacuum applied to extraction wells to volatilize organics, may include recovery of gases	Difficult to strip volatiles in soils with low permeability. Additional wells and special operating techniques may be required. Difficult to strip low volatile compounds or heavy hydrocarbons such as diesel and waste oil.
	Thermally Enhanced Soil Vapor Extraction	X		Area of contaminated is heated via steam injection, hot air injection, or radio frequency heating. Contaminants are extracted as described under soil vapor extraction. The elevated temperature facilities remove organics with high boiling points.	Steam extraction, hot air injection and radio frequency heating are being tested at pilot scale. Limited studies on effectiveness in soils with low permeability. Field test in 1992.
	Bioremediation	X		Air is drawn through area of contamination in the vadose zone, enhancing growth of native bacteria. Nutrients can be added if necessary to stimulate degradation.	Air flow involves an order of magnitude smaller flow of air/ volatiles compared to soil vapor extraction.
	Bioventing	X		Nutrients are injected into soil and air is drawn through area of contamination enhancing growth of native bacteria.	Air flow involves an order of magnitude smaller flow of air/ volatiles compared to soil vapor extraction and contaminants are susceptible to bacterial breakdown.
	Precipitation		X	Immobilization of metals by injection of solution to precipitate dissolved species.	Difficult to control in soils with low permeability.
	Oxidation/ Reduction		X	Similar to soil flushing. Solution will detoxify contaminants by altering oxidation state of compound through loss or gain of electrons.	In situ application at hazardous waste sites is field tested. Can generate more toxic compounds.

TABLE 2.11 (continued)

PRELIMINARY SCREENING OF SOIL REMEDIAL TECHNOLOGIES

Remedial Action Category	Technology	Retain	Reject	Description	Comments
EXCAVATION	Excavation	X		Physical removal of contaminated materials for treatment or disposal.	Application to contaminated materials in spill and storage areas.
	Temporary Storage	X		Storage of wastes until treatment capacity and/or disposal are available.	Would be used in conjunction with treatment and/or disposal.
	Waste Piles		X	Surface storage of excavated materials.	Long term storage not applicable.
DIRECT TREATMENT METHODS	Thermal Destruction	X		Thermal destruction of contaminant by combustion under controlled conditions. Requires treatment of gas released and disposal of residual ash.	Public acceptance, availability of unit and quantity of waste may preclude on-site use. Off-site incineration is a viable option.
	Solidification/ Stabilization	X		Incorporation of contaminants into a solid matrix to reduce mobility, improve handling, problem at HAA.	Effective for metal contaminants at HAA. Leaching can occur with organics.
	Biological Treatment	X		Surface tilling of soil or above ground bioventing to aid microbial degradation. Nutrients and microorganisms may be added to enhance biodegradation of contaminants.	Suitable for TPH and other organic contaminants.
	Low Temperature Thermal Desorption	X		Heat soil to desorb volatile and semivolatile compounds.	Suitable for contaminant and soil type at HAA.
	Chemical Oxidation	X		Addition of oxidizing agents to degrade organic contaminants.	Level of treatment is relatively high with organics. But has potential problem with soils containing metals.
	Soil Washing	X		Soil is washed with solution such as water, surfactants, extractants, acid, and alkaline to remove organics or metals.	Can be used to remove organics and inorganics from soil. For clayey soils, leaves large volume of wastewater and contaminated fines.
DISPOSAL	Landfill	X		Disposal of excavated materials into an approved hazardous waste facility. Materials may be drummed or disposed of in bulk.	Volume of material does not warrant construction of an on-site RCRA landfill. Off-site landfill applicable and depends upon concentrations of land-banned compounds.
	Land On-Site Disposal	X		Soils backfilled in a designated area on the base.	This could only apply to non-RCRA contaminated soil (i.e., TPH). Pretreatment of soil may be needed prior to disposal.

and hot air have also been injected into the soil to increase the rate of volatilization in silt and clay soils. This technology, known as thermally enhanced soil vapor extraction, could be used to reduce the treatment time for VOCs and SVOCs contaminated silt and clay soils which are encountered at HAA.

In-situ Treatment: Bioremediation. Nutrients are injected into soil and air is drawn through area of contamination enhancing growth of native bacteria to degrade organic compounds. Since air flow is kept low, it may be amenable to the soils on site.

In-situ Treatment: Bioventing. Bioventing involves drawing or blowing air through the vadose zone as a means of providing oxygen to the contaminants and enhancing bioremediation. Nutrients and/or microorganisms may be injected into subsurface if needed. Bioventing is only applicable if oxygen is the limiting factor to bioremediation and if the constituents of concern are amenable to biological degradation. The flow rate of air through the subsurface is substantially slower than that for soil vapor extraction and may be more applicable to tight soil structures found at HAA. Because the air flow is low, emissions treatment systems are smaller than those required for soil vapor extraction or in some cases may be eliminated entirely.

Excavation: Excavation. Excavation was retained as a viable technology because it is appropriate at sites where a limited volume of contaminated soil would require removal. Once removed, the contaminated soils would either be treated or transported to an appropriate landfill site.

Excavation: Temporary Storage. Temporary storage of soil was retained for possible use with other technologies which would permanently detoxify and/or dispose of the contaminants. It is an option that would need to be developed in conjunction with other options. If wastes were stored, a storage area would need to be designed to prevent migration of contaminants from the primary medium into surrounding uncontaminated areas.

Direct Treatment: Thermal Destruction. Thermal destruction is used to treat organic contaminants associated with either excavated soils or solids. On-site thermal destruction was rejected as a treatment method due to the low volume of material possibly requiring treatment and the relatively high cost of mobilizing/demobilizing and operating a treatment unit on site. In addition, ash disposal would remain a problem. Off-site thermal destruction remains a possible option.

Direct Treatment: Stabilization/Solidification. Soil stabilization/solidification is a treatment process that serves to reduce the hazardous nature of contaminated soils by converting the contaminants into their less soluble, mobile or toxic form. This technology has proven effective for heavy metal contamination.

Stabilization is the conversion of hazardous constituents to a more chemically stable form. Solidification binds the hazardous waste constituents into a solid mass with low permeability that resists leaching. Typical solidification agents include asphalt-based, cement-based, silicate-based, thermoplastic-based, and organic polymer-based compounds. Excavated soils can be treated above ground with chemicals in

commercially available mixing equipment. The chemical and physical characteristics of the waste drive the selection and application of the stabilization/solidification compound.

Direct Treatment: Biological Treatment. Surface tilling and above ground bioventing are both effective means of introducing oxygen into the treatment cell in order to stimulate biodegradation. Nutrients and possible other microorganisms can be easily mixed with the soil if needed. Biological treatment is an effective, well-documented technology for treating TPH and other organics.

Direct Treatment: Low Temperature Thermal Desorption. Several thermal treatment options are available for removing and/or destroying organic contaminants from soil. Low temperature systems process contaminated soils through a pug mill or rotary drum equipped with heat transfer surfaces. Residence times and temperature can be adjusted in these units to remove heavier diesel and fuel oil organics. Volatilized gases released from these units require special treatment prior to release to the atmosphere. The applicability of the low temperature thermal process is dependent upon the soil characteristics, the volume of soil to be treated, and the range of contaminants present. Soils with high moisture content may require pretreatment to avoid high energy requirements, and soils with a high clay or silt content such as those at HAA may require preshredding. This technology is particularly applicable for low permeability soils.

Direct Treatment: Chemical Oxidation. Oxidizing agents such as hydrogen peroxide and ozone and catalysts are added to soil to degrade organic contaminants. Advantages include high level of treatment, and stimulation of biodegradation if ozone is used. A potential disadvantage is the ionization of metals to more mobile states and decrease of possible sorption sites.

Direct Treatment: Soil Washing. Soil washing is a common chemical/physical treatment method for organic and heavy metal contaminated soils. Studies indicate a large percentage of soil contamination is usually associated with the smaller fines can be separated from the coarse material, the volume of contaminated soil requiring further treatment can be reduced. Washing fluids including water mixed with surfactants, extractants, acidic solutions, and alkaline solutions have been used to remove contaminants from the coarse soil fraction. Soil washing has been shown effective in the treatment of soils contaminated with phenols, heavy metals, TPH, and oily substances (EPA, Physical/Chemical Treatment of Hazardous Wastes 1990, CERI-90-16). Surfactants are the most promising washing solutions for organic contaminants, while acids are generally used for the treatment of metals. For clayey soils, process can generate a large volume of secondary wastewater and contaminated fines which must be treated.

Disposal: Off-site Landfilling. Soil containing hazardous waste (as defined in 40 CFR 261) at levels greater than land disposal limits must be treated prior to disposal in landfill. This would include soils contaminated with halogenated hydrocarbons. Treatment requirements and treatability variances are discussed in 40 CFR 261 through 268.

Disposal: On-site Landfilling. This disposal option refers to disposing of soils contaminated with fuels or other non-RCRA constituents at designated areas on the base and not necessarily at the site where the soils were excavated. TPH contaminated soil is considered hazardous by the State of California. The concentration limits of the soil prior to disposal will be dependent on criteria set by the SFRWQCB, and possibly other state agencies as well as soil type, depth to groundwater and other characteristics of the disposal site.

2.4.1.2 Rejected Soil Remedial Technologies

In-situ Treatment: Precipitation. Precipitation methods are designed to render the contaminants insoluble and prevent further migration in the soil. Precipitation was rejected because it is still in the developmental stages and is not applicable to the types of contaminants present at HAA.

In-situ Treatment: Oxidation/Reduction. These methods are similar to solvent flushing: the main difference being the reagents used to wash the soil. Oxidation utilizes ozone, hypochlorite, or hydrogen peroxide as its reagent; reduction utilizes water with lime or sodium hydroxide as its reagent. These technologies were rejected because the treatment of one contaminant may create another harmful contaminant from a compound that was previously innocuous.

In-situ Treatment: Solidification/Stabilization. Solidification/stabilization is injected into the soil to form macromolecules. Uniform mixing is difficult to achieve; therefore, technology is more amenable to sludges, which is not a problem at HAA.

In-situ Treatment: Vitrification. In-situ vitrification is a thermal process which converts contaminated soils into chemically inert and stable glass-like materials. The process uses electrodes inserted into the soils (clayey soil containing silicate is ideal) to pass a current which generates temperatures upwards of 3600° C. Soil materials melt at approximately 2000° to 2500° C causing metallic materials to fuse or vaporize and organic compounds to pyrolyze into the glass matrix. A cap is used to capture offgas during the operation. After cooling, the stable material is left in place. This technology is in pilot scale, but its operating cost is expected to be very high for soils with high moisture content; most of the soils at HAA have high moisture content.

Excavation: Waste Piles. Waste piles are not a long-term or permanent solution and do not, therefore, follow the guidelines in SARA.

2.4.2 Groundwater Remedial Technologies

The candidate technologies which may remediate groundwater at HAA are listed in Table 2.12. Retained technologies are identified for later inclusion in remedial alternatives. Rejected technologies are identified and reasons are given for rejection. This section briefly describes the applicable technologies and relates important contaminant and site characteristics that may influence implementation of a technology.

TABLE 2.12

PRELIMINARY SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES
HAA

Remedial Action Category	Technology	Retain	Reject	Description	Comments
CONTAINMENT	Subsurface Drains	X		An interceptor conduit used to collect and convey groundwater via gravity flow. The conduit can be either perforated pipe or a highly permeable material.	Interception of groundwater may be necessary downgradient of source areas.
	Subsurface Barriers		X	A cut-off wall of low permeability is installed below grade to prevent or redirect groundwater flow.	Migration is slow. Not applicable to this site.
	Grading		X	Changing the slope of the ground surface to prevent surface water infiltration.	Not a necessary action given existing site topography.
	Capping	X		A low permeability barrier is placed over the ground surface to minimize infiltration of surface water into groundwater	Discussed under soil technologies.
IN SITU TREATMENT	Hydrolysis		X	Similar process to soil flushing. Solution is a base to attack the water or hydroxyl ion resulting in bond cleavage.	Hydrolysis products may be more toxic than original contaminants. Technology not amenable to contaminants of concern.
	Polymerization		X	Immobilization technique where a catalyst is injected into groundwater to form larger compounds	Limited data exists as to reliability and effectiveness of immobilization. Best suited to clean up following spills.
	Chemical Dechlorination		X	Injection of and alkali polyethylene glycolate solution to remove chlorine atoms by a nucleophylli substitution reaction.	The process is being developed to treat PCBs, but may be used to treat other chlorinated and halogenated hydrocarbons. The in-situ process is still conceptual, may produce more contamination than originally exists.
	Permeable Treatment Beds		X	A trench is filled with activated carbon or an ion exchange resin to treat groundwater as it flows through.	Only temporary solution, resin and contaminant must be removed. Difficult to control uniform adsorption. Highly susceptible to plugging.
	Biostimulation	X		Oxidizers such as hydrogen peroxide or oxygen and nutrients are injected into the aquifer to stimulate bacterial growth. Stabilizers may also be added to control H_2O_2 decomposition.	Difficult to control oxygen levels along the plume. May require several injection wells in clayey soils in order to provide oxygen throughout the area of contamination.

TABLE 2.12 (continued)

Remedial Action Category	Technology	Retain	Reject	Description	Comments
	Air Sparging	X		Air is injected deep into the saturated zone which volatilizes contaminants that had been dissolved in the groundwater or adsorbed onto the soil. The entrained organics are carried by the air bubbles into the vadose zone where they can be captured by a soil vent system or once mobilized can be captured by groundwater extraction system. Air sparging will also enhance neutral biodegradation.	Air sparging can enhance removal of volatile contaminants. Air sparging must be used in conjunction with soil venting in order to capture the mobilized contaminants. Because contaminants have been mobilized, good hydraulic control of the groundwater is essential to contain the plume.
EXTRACTION	Groundwater Pumping	X		Pumping from a dewatering system and/or trenches to withdraw contaminated groundwater.	Withdrawal of groundwater may be necessary to collect contaminants and minimize migration.
DIRECT TREATMENT METHODS	Off-site Treatment		X	Conveyance of waters via piping or hauling to TSDF	Insufficient capacity and possible administrative problems.
	Flocculation/ Precipitation	X		Addition of flocculation agent associated with rapid mixing to change equilibrium and cause formation of large particles. Solids are allowed to settle under quiescent conditions. Changing pH can promote precipitation depending on the nature and concentration of the metals in the water.	Applicable to removal of suspended solids. Can substantially add to mass of solids to be disposed of. Changing pH is applicable to removal of dissolved solids.
	Sedimentation		X	The settling of suspended solids by gravity in a quiescent vessel. Includes a method, physical or mechanical, to collect sludge from bottom.	Can only treat suspended solids. Not likely to meet discharge requirements.
	Filtration	X		Removal of suspended solids from liquid stream by forcing through porous media. Media may be single size or mixed.	Used as a pretreatment for many processes. A means of storing and drying the filter cake prior to disposal is needed.
	Air Stripping	X		A mass transfer process to transfer volatile contaminants in water to gas. System design may include treatment of air stream.	A demonstrated technology for removing volatile organics from groundwater.
	Steam Stripping		X	Similar to air stripping except steam is used as the stripping gas.	Effective, but not competitive with air stripping, unless an inexpensive source of steam is readily available.
	Steam Distillation		X	Similar process as steam stripping, but includes solvent recovery.	Separation of solvent cost effective only if recycled. Insufficient concentrations present to make this a viable option.

TABLE 2.12 (continued)

Remedial Action Category	Technology	Retain	Reject	Description	Comments
DIRECT TREATMENT METHODS	Activated Carbon Adsorption	X		Contaminants pass through a vessel containing activated carbon. Organics adsorb to carbon by physical/chemical forces.	An applicable method for removing volatile and semi-volatile organics from groundwater.
(continued)	Biological Treatment	X		Biological degradation technique where Bacteria utilize supplied oxygen to oxidize organics to CO_2.	Effective for fuel contaminants. Techniques to treat VOCs and SVOCs are being developed.
	Ion Exchange and Reverse Osmosis		X	Concentrates inorganic salts and some organics by forcing the solvent through a semi-permeable membrane or a porous ion exchange media.	Does not treat contaminants identified at the site.
	UV/Oxidation	X		Ultraviolet light is used in conjunction with an oxidizing agent. UV light transforms O_2 to ozone which is very reactive with organics. An effective treatment process for a wide range of organics.	UV/oxidation power requirements can be very expensive. System is very susceptible to fouling and maintenance costs can be high. UV/oxidation, however, destroys the contaminants rather than transferring them to another medium.
	Liquid/Liquid Extraction		X	Contaminant is removed from one liquid medium into another easily extractable liquid that has a higher absorption capacity.	Primarily used for phenolic extraction, which is not an issue at HAA.
	Dissolved Air Flotation		X	Liquid is saturated with air at high pressure forming bubbles of air to float contaminants to surface. Removes fine particles or oils and greases.	Not cost effective when compared to other methods of solids removal. Also, solids and oil/grease are not present in significant quantities.
	Oil/Water Separation		X	Oil is allowed to float to surface in a quiescent tank and then skimmed off.	Large quantities of oil are not present at HAA.
	Hydrolysis		X	Similar process as described under in situ treatment.	Hydrolysis products may be more toxic than the original contaminants.
	Chemical Dechlorination		X	Similar process as described under in situ treatment.	Mainly applied to PCB contamination.
	Oxidation/ Reduction		X	Alteration of compound oxidation state through gain or loss of electrons.	Not likely to meet discharge requirements.
	Aerated Lagoons		X	An earthen lagoon used to biologically treat waste through microbial degradation. Air is added to water to promote the bioprocess.	Insufficient volumes and concentration.
	Stabilization Ponds		X	A shallow lagoon where degradation occurs through bacteria and algae.	Insufficient volumes and concentrations.
DISPOSAL	Surface Water Discharge	X		Discharge under a NPDES permit.	Discharges to San Pablo Bay must meet NPDES effluent limits.

TABLE 2.12 (continued)

Remedial Action Category	Technology	Retain	Reject	Description	Comments
	Alluvial Groundwater Discharge	X		Uses either wells or a trench.	May be appropriate based on-site conditions.
	Deep Well Injection		X	Injection of wastes into geologic formations completely isolated from groundwater and drinking water.	Geologic conditions at the site are unsuitable for deep well injection. Off-site disposal also is not viable.
	POTW Discharge	X		Discharge to local POTW.	Must meet Novato Sanitary District treatment standards.

2.4.2.1 Retained Groundwater Remedial Technologies

Containment: Subsurface Drains. Subsurface drains and barriers may be effective in controlling the flow of groundwater in specific areas of the site. The drains would collect groundwater before it entered a contaminated area, preventing the contamination of clean water, as well as inhibiting the migration of contaminants from the source area. Additionally, for shallow groundwater and soils with low hydraulic conductivity, the use of drains and barriers is effective in preventing further migration of previously-contaminated groundwater.

Containment: Capping. Capping is used to limit the migration of contaminants from soil to groundwater due to infiltration of precipitation. Capping was previously discussed and retained as appropriate to HAA as a soils remedial technology.

In-situ Treatment: Biostimulation. Nutrients and a source of oxygen are injected into the subsurface to stimulate the indigenous bacteria to metabolize the contaminants present in the groundwater.

In-situ Treatment: *Air Sparging.* Air sparging introduces air into the groundwater to facilitate removal of volatile contaminants from the groundwater by transferring the contaminants into the vadose zone where they can be removed by in-situ vapor extraction technologies. This mobilization accelerated remediation of groundwater increases the possibility of spreading the contamination and therefore air sparging is retained, but it should be used in conjunction with plume control such as groundwater extraction and with soil venting. This technology also provides air to enhance bioreclamation of both groundwater and soils.

Extraction: Pumping. The soil formations which overlie the HAA site consist primarily of silty clay and exhibit a low permeability. These conditions are not ideal for the use of pumping to remove contaminated groundwater. However, extraction of groundwater is an applicable technology in conjunction with subsurface drains at HAA and could be used with direct treatment for contaminant removal.

Direct Treatment: Flocculation/Precipitation. This technology is used for removal of suspended inorganic contaminants which are present in HAA groundwater. It is retained as a pretreatment step to treatment of inorganic contaminants.

Direct Treatment: Filtration. Filtration is a pretreatment step to many processes to remove solids. Filtration often follows precipitation to remove inorganic contaminants.

Direct Treatment: Air Stripping. Direct treatment by air stripping is an effective and well-established technology for the removal of volatiles and some semivolatiles from groundwater. Removal efficiencies depend upon relative concentration of contaminants, air-contaminant interface time, and temperature.

Direct Treatment: Activated Carbon Adsorption. Many of the organic contaminants in the groundwater can be effectively treated through a granular-activated carbon treatment unit. This method has been proven effective and reliable in removing a wide variety of organic contaminants. However, a drawback is the subsequent

regeneration, treatment, or disposal of the spent carbon. Activated carbon may also be used in conjunction with air stripping as part of an offgas treatment system.

Direct Treatment: Ultraviolet Light/Oxidation. Ultraviolet-ozone (or hydrogen peroxide) oxidation is an effective treatment for a wide range of organic compounds. Ozone has been used for many years for disinfection, odor control and other oxidation processes. The controlled combination of ozone (or hydrogen peroxide) and ultraviolet light induces rapid photochemical oxidation of halogenated organic compounds. This system offers the advantage of detoxifying contaminants through chemical decomposition rather than simply transferring them to another media. However, incomplete oxidation will generate other organic compounds that may require further evaluation and possibly treatment. Although this oxidation process has been used at similar sites for removing VOCs, a treatability study is required to determine its effectiveness at HAA. This technology is suitable at low flows as expected at HAA.

Discharge: Surface Water Release. Surface water discharge of treated groundwater would necessitate meeting the requirements of a NPDES permit. The likely discharge point would be one of the forks of Brush Creek.

Discharge: Alluvial Recharge. Alluvial recharge of treated water may utilize injection wells or an infiltration trench. A common practice is to recharge treated water upgradient of contaminated areas to decrease time required for complete remediation.

Disposal: POTW Discharge. Treated water can be discharged to the local POTW which is Novato Sanitary District. The POTW could establish discharge requirements based on their NPDES permit conditions, the treatment process used, and their capacity to accept new discharges. However, the Novato Sanitary District is reluctant to take wastewater from cleanup projects unless there is no other reasonable alternative.

2.4.2.2 Rejected Technologies

Containment: Subsurface Barrier. Subsurface barriers are used to contain or divert groundwater flow. Groundwater is not currently causing immediate risks to public health or the environment.

In-situ Treatment: Hydrolysis, Polymerization, Dechlorination and Permeable Treatment Beds. In situ treatment utilizes chemicals or biological agents to reduce or immobilize contaminants in soil and groundwater in place. In general, in situ methods are still in the development stage for the organic compounds present at HAA and only a few have been used successfully in actual site remediation. These few are not applicable to the conditions at HAA.

Direct Treatment: Off-site Treatment. Off-site treatment at the proposed Landfill 26 groundwater treatment facility was rejected due to the need for a buried conveyance pipeline and administrative difficulties resulting from potentially different treatment requirements.

Direct Treatment: Sedimentation. Sedimentation is commonly used in conjunction with precipitation or where large concentrations of suspended solids are present in waste streams. Neither problem is anticipated at HAA; thus, the technology was rejected.

Direct Treatment: Steam Stripping and Distillation. Steam stripping and distillation are similar processes to air stripping. The steam, because of its higher temperature, is more effective at removing high molecular-weight volatiles normally not removed by conventional air stripping techniques. Steam distillation includes recovery of the organics. The technologies were rejected because the principal contaminants are not as high molecular weight volatiles and these technologies are not cost effective when compared to air stripping unless an inexpensive source of steam becomes available.

Direct Treatment: Ion Exchange and Reverse Osmosis. Ion exchange and reverse osmosis are processes that remove contaminants from one solution by concentrating them in another solution by use of ionic charge or osmotic pressure. These technologies are more suited to inorganic contaminated wastewater. Because groundwaters at HAA do not exhibit these characteristics, these two technologies were rejected from further consideration.

Direct Treatment: Liquid/Liquid Extraction. Liquid/liquid extraction techniques can result in high cost unless the extracted material is recovered and reused. As a general case, it is most suited to phenols, which are not a concern at HAA. Both of these processes were rejected because they are not applicable to the contaminants and conditions at the site.

Direct Treatment: Dissolved Air Flotation and Oil/Water Separation. Dissolved air flotation (DAF) involves concentrating solids by floating them to the surface of a tank on bubbles of air and then using a skimmer to remove the accumulated solids. Oil/water separation skims oil from a quiescent tank. Neither solids nor large volumes of oil have been identified as problems at the site; therefore, both technologies were rejected from additional consideration.

Direct Treatment: Hydrolysis, Dechlorination, Oxidation, and Reduction. These technologies were discussed under in situ treatment methods. Technical theory behind the techniques are basically the same for direct treatment as for in situ treatment. They were rejected from further consideration because they are not applicable to the contaminants found at HAA.

Direct Treatment: Aerated Lagoons and Stabilization Ponds. These treatment technologies were rejected because they are not as efficient as air stripping for removing the low concentrations of volatiles present and because other methods of biological treatment are more effective at removal of contaminants.

Disposal: Deep Well Injection. Deep well injection off-site of HAA is not a viable alternative disposal technology for contaminated groundwater. There are approved commercial facilities in Oklahoma which may accept the liquid wastes, but the costs associated with transporting groundwater to Oklahoma would be prohibitive.

SECTION 3

DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

The purpose of this section is to combine applicable technologies into appropriate remedial action alternatives and to conduct an initial screening of these alternatives.

3.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Potential remedial action alternatives were developed for soil and groundwater contamination on a site-wide basis. These alternatives will be screened for each site in subsection 3.2. The range of alternatives for each medium include no action, containment, and a range of treatment and disposal options. A no action alternative represents public health and environmental conditions in the absence of remedial action. It also provides a baseline for determining the effectiveness of other alternatives and is required based on CERCLA RI/FS guidance documents.

3.1.1 Soil Remedial Alternatives

The site-wide soil remedial alternatives are presented in Table 3.1. The alternatives include no action, containment (capping), in-situ treatment (soil flushing, in-situ bioventing, thermally enhanced soil vapor extraction), and direct treatment (biological degradation, stabilization/solidification, low temperature thermal desorption and off site thermal destruction). Following are brief discussions of each alternative:

Soil 1: No Action (S1)

The no action alternative was included to provide a baseline against which project costs and changes in environmental and public health risks can be compared. It may also be an acceptable alternative for some of the sites at HAA. Sites which have groundwater contamination will require long-term groundwater monitoring to be implemented in conjunction with the no action alternative. The no action alternative cost estimate can be higher than remedial alternatives because of the cost of monitoring over a longer period.

Soil 2: Capping (S2)

Capping is recommended when a physical barrier will prevent contaminants from affecting human health or the environment. Capping minimizes infiltration of rainwater and the further development of a contaminant plume. Often, it can be used together with groundwater extraction technology to contain migration. Applying three feet of cover material is recommended for sediments (and soils if Wetland Option selected) that

TABLE 3.1

DEVELOPMENT OF SOIL REMEDIAL ACTION ALTERNATIVES

Alternatives	**Type of Alternative Action** (1)
S1	No Action
S2	Asphalt Capping or Covering with Soil
S3	In-situ Soil Flushing Groundwater pumping and treatment
S4	In-situ Bioremediation
S5	In-situ Soil Vapor Extraction (2)
S6	Excavation Biological Treatment (aboveground)
S7	Excavation Solidification/Stabilization Landfill
S8	Excavation Low Temperature Thermal Desorption
S9	Excavation Off-site Thermal Destruction
S10	In-situ Bioventing
S11	Excavation Chemical Oxidation
S12	Excavation Soil Washing

Notes

(1) Temporary storage is included in all alternatives involving excavation.

(2) In-situ soil vapor extraction is a representative technology which includes technology groups involving thermal and other vapor extraction enhancement techniques.

exceed the "with-cover" (low concentration) sediment screening criteria for soil with low concentrations of TPH (10 mg/kg to 100 mg/kg). Capping with soil costs $4 to $5 per cubic yard.

Soil 3: In-situ Soil Flushing (S3)

Soil flushing is an effective remedial action to desorb and remove organics or metals in permeable soils. Cleanup is accelerated compared to natural flushing. The type of soil overlaying the zone of contamination can absorb and can alter the effectiveness of the solvent. Soil flushing is more effective in soils with a low organic content. Solvents are selected to desorb, and mobilize contaminants and therefore plume control is essential. For less permeable soils, delivering the flushing solution to the soil may require an extensive infiltration system and collecting and extracting the elutriate may require drainage trenches. This is effectively used in conjunction with groundwater extraction. The cost of in-situ soil flushing in soil ranges from $100 to $150 per cubic yard.

Soil 4: In-situ Bioremediation (S4)

In-situ bioremediation methods may be effective when contaminated soils are located beneath buildings, roadways, or other structures which prohibit to excavation. Field tests in recent years show some contaminants are effectively mitigated by soil venting to stimulate in-situ aerobic biodegradation. For soils with low permeability, bioremediation is difficult to control. An infiltration system will be necessary to deliver the oxygen and nutrients. The cost of in-situ bioremediation ranges from $50 to $100 per cubic yard of soil.

Soil 5: In-situ Soil Vapor Extraction (S5)

Soil vapor extraction (SVE) has successfully been used to mobilize and remove volatile contaminants from the vadose zone. Because air is significantly more mobile in the subsurface relative to water, soil vapor extraction has a much broader application than soil flushing alone. SVE is effective for contaminants with vapor pressures as low as 0.1 mm of mercury and the process is much more efficient for more volatile compounds. The number of wells required to clean up a site is dependent on the area of influence, the size of the blowers and the permeability of the soil. Wells can be screened to focus the air flow through the target cleanup depths. Air emissions control may be required which would significantly impact the capital and operating costs. Off-gas treatment may include combustion (for high concentrations of hydrocarbon in the off gas), catalytic oxidation (for moderate concentrations) or carbon adsorption (for lower concentrations or for volatiles other than hydrocarbons).

Thermally enhanced soil vapor extraction is suitable for deep soils or soils under structures. It increases the rate of volatilization for fuel hydrocarbons, VOCs and SVOCs in soils and reduces the treatment time. If the radio frequency heating technique is applied to shallow soils, an impermeable cover has to be used to prevent short circuiting with ground surface. If steam is used to heat the subsurface, a condensate collection and treatment system will be needed. Although thermally enhanced soil vapor extraction offers a potentially high level of treatment, it is not economically feasible in very tight soils and does not remediate nonvolatile organics, metals, or other inorganics. Costs for

these in-situ heating methods have not been firmly established but are expected to range from $50 to $75 per cubic yard and would dependent significantly on air emissions control requirements.

Soil 6: Excavation and Biological Treatment (S6)

Biotreatment of contaminated soils is effective for a wide variety of organics including the petroleum hydrocarbons, VOCs and SVOCs at HAA. Microbial degradation of fuel hydrocarbons has been extensively documented in literature, and many successful field demonstrations have been reported. Treatment effectiveness on VOCs and SVOCs, especially chlorinated compounds is less certain and a treatability study is needed. Biodegradation can be enhanced by oxygen and nutrients with aboveground mixing and tilling or by blowing/or pulling air through the soil. The cost of biotreatment varies with soil volume and treatment time, but it is expected to be in the range of $25 to $35 per cubic yard where significant volumes of soil require treatment.

Soil 7: Excavation and Solidification/Stabilization (S7)

This alternative is applicable for soils which contain unacceptable levels of inorganics such as heavy metals. A number of constituent and soil factors can impede the solidification/stabilization process including the presence of very fine materials (i.e., 7.4 x 10^{-5} meter particle size), acidic pH, excessively flat waste particles, soil, or high moisture content. Pretreatment by drying or pH adjustments may be required. Inorganic compounds such as calcium sulfate or soluble salts of copper, lead or zinc also interfere with successfully solidifying the contaminated soil (EPA 1990c). The presence of certain organic compounds can reduce the effectiveness of solidification and it may be necessary to remove organic compounds prior to treatment. The cost of solidification/stabilization is dependent on soil volume, but range from $50 to $100 per cubic yard. Following treatment, and after the solidified material has passed the Toxicity Characteristic Leaching Potential (TCLP) test, it can be returned to the excavation for burial or shipped to an off-site landfill.

Hydrocarbon contaminated soil that does not contain other hazardous components can be treated in a solids recycling unit. The treated soil would then be mixed with solidifying agents to form a light weight aggregate product which is marketable. The generator is then issued a recycle certificate. Each recycling facility has their own limits on the makeup and hydrocarbon concentrations that can be accepted. Prices range from $75/ton to $100/ton of soil.

Soil 8: Low Temperature Thermal Desorption (S8)

Low temperature thermal desorption has been successful at removing volatile organics associated with fuel and solvent contaminated soil. The vaporized contaminants are recondensed and collected for recycling or disposal. This technology is particularly applicable for low permeability soils which are difficult to treat in-situ and high concentrations of low volatility organics. Soils with high moisture contents, such as sediment, may require pretreatment to minimize energy consumption. These units can be either stationary facilities or trailer mounted. The cost of treating soils in these units varies with soil volume but is generally in the range of $80 to $130 per cubic yard.

Soil 9: Off-Site Thermal Destruction (S9)

Excavation and off-site thermal destruction is an effective method to destroy organics in soils. Thermal destruction cost is high, ranging from $200 to $500 per cubic yard. However it can still be economically feasible if the volume of contaminated soil from a site is small.

Soil 10: In-situ Bioventing (S10)

In-situ bioremediation methods may be applicable when contaminated soils are especially deep, or beneath buildings, roadways, or other structures and are difficult to excavate. Bioventing has been used successfully to remediate hydrocarbon contamination at multiple sites across the country in a wide range of soils, including silts and clays. Simply drawing air through the soil is sufficient to stimulate the indigenous microbes and enhance biodegradation. Oxygen is usually the limiting factor. If additional nutrients or other microorganisms are necessary, an infiltration system could be used. Soils with low permeability can greatly reduce the area of influence around the injection/extraction well and in those areas, additional property screened wells may be required. Costs for bioventing range from $10/cubic yard to $80/cubic yard depending on the volume and characteristics of soil to be treated. These costs assume additional nutrients/microbes are not needed, emissions treatment is not needed, and a reasonable area of influence can be obtained around the injection/extraction well.

Soil 11: Chemical Oxidation (S11)

Chemical oxidation is effective for oxidizing organics to low levels. This technology is most suitable for soils containing organics and only a small amount or ideally no metals, because metals ionize and become more mobile. This technology is currently being used at the POL area to clean TPH contaminated soils to reportedly 20 to 30 mg/kg. For sites containing metal contaminants, a treatability study may be necessary and additional treatment of metals may be required. Cost of chemical oxidation ranges from $70 to $160 per cubic yard of soil.

Soil 12: Soil Washing (S12)

Soil washing may be used to remove metals and organics. However, soils containing a complex mixture of contaminants are not recommended for soil washing because of the problems in selecting an effective extraction fluid. Soil washing is most effective when applied to sandy soils and soils that have low humus and clay content. For clay soils, it can generate a large volume of contaminated secondary water which does not readily separate and therefore increases treatment costs. This technology is potentially feasible only if a groundwater treatment system will be on site. Costs are estimated to range from approximately $80 to $120 per cubic yard for sandy soil and higher for clayey soils.

Comparison of In-situ versus Above Ground Treatment

In general, surface treatment of hydrocarbon contaminated soils has several advantages over in-situ treatment, especially in clayey soils most typical of the HAA sites. Excavated soils can be mechanically manipulated to produce a more homogeneous mixture of sands, silt and clays. In the in-situ environment, clay lenses frequently result

in a non-uniform distribution of contaminants, making uniform treatment difficult. Contaminants tend to reside in small soil pores while the carrier fluid (i.e., water, air) tends to seek paths of less resistance such as larger soil pores. In the aboveground remedial methods oxygen, nutrients or heat can be evenly distributed and treatment is more rapid and uniform. Another factor to consider is that sampling of soils in aboveground operations is simple and much more reliable than soil borings which are subject to subsurface nonuniformities.

Soil excavation could impact the required cleanup criteria. In order to comply with ARARs, PRGs, or cleanup criteria, additional cleanup requirements may be imposed once the soil is excavated from the site. For example, soil which is treated to meet TPH cleanup criteria may also contain levels of heavy metals below the cleanup criteria, but once excavated, disposal of the soil must meet the more restrictive RCRA land disposal restrictions for metals.

3.1.2 Groundwater Remedial Alternatives

The site-wide groundwater remedial alternatives are presented in Table 3.2. The alternatives include no action, in-situ treatment (biostimulation and air sparging), direct treatment (carbon adsorption, air stripping/carbon adsorption, biological degradation, and UV oxidation). Following are brief discussions of each alternative:

Groundwater 1: No Action (GW1)

The no action alternative was included to provide a baseline against which project costs, and changes in environmental effects of public health threats can be compared. It may also be an acceptable alternative for some of the sites at HAA. Sites which have groundwater contamination will require long-term groundwater monitoring to be implemented in conjunction with the no action alternative.

Groundwater 2: In-situ Biostimulation (GW2)

In-situ biostimulation has been successful in remediating petroleum spills. Nutrients such as ammonia and phosphates, and an oxygen source, such as sparged air or hydrogen peroxide, are injected into the groundwater. These amendments cause naturally occurring bacteria to grow and degrade the petroleum present. Hydraulic control is essential to contain plume migration. Tight clay formation can be a significant obstacle to complete remediation. It may be impossible to force nutrients and even oxygen through the pores in a very low permeability formation. Without oxygen the metabolic rates of the micro-organisms remain low and pockets of contamination can be left behind.

Groundwater 3: Air Stripping and Carbon Adsorption (GW3)

For groundwater containing volatile and semivolatile organic contaminants, air stripping is used is used in conjunction with liquid-phase carbon adsorption. The air stripper removes the more volatile compounds, and liquid-phase carbon removes the less volatile compounds. The combined system would reduce the loading on a carbon system operating alone. Often gas-phase carbon units are also used to treat the stripper off-gas.

TABLE 3.2

DEVELOPMENT OF GROUNDWATER REMEDIAL ACTION ALTERNATIVES

Alternatives	
GW1	No action Long-term groundwater monitoring
GW2	In-situ Biostimulation
GW3	Pumping (subsurface drains) Treatment by: precipitation/filtration air stripping carbon adsorption Discharge to: GW3a. Surface water GW3b. POTW GW3c. Reinjection
GW4	Pumping (subsurface drains) Treatment by: precipitation/filtration carbon adsorption Discharge to: GW4a. Surface water GW4b. POTW GW4c. Reinjection
GW5	Pumping (subsurface drains) Treatment by: biological degradation Discharge to: GW5a. Surface water GW5b. POTW GW5c. Reinjection
GW6	Pumping (subsurface drains) Treatment by: precipitation/filtration UV/Oxidation Discharge to: GW6a. Surface water GW64b. POTW GW64c. Reinjection
GW7	In-situ Air Sparging

Dissolved solids are present in the HAA site groundwater, which can foul air stripper column therefore pretreatment by filtration or precipitation may be necessary.

Groundwater 4: Carbon Adsorption (GW4)

Treatment of groundwater by activated carbon will provide removal of organics found at the site. The maximum TPH concentration detected at the site is 14,000 μg/L at one location in the POL area, therefore the average concentration expected at the site should be within the capability of carbon systems. The low flow rate expected at the site may make this an attractive option. Dissolved solids are present in the HAA site groundwater, which can poison carbon beds, therefore pretreatment of the solids may be necessary.

The Landfill 26 treatment plant, which is being installed by the Corps of Engineers, may be considered as another alternative for treating groundwater. The treatment operations will consist of a coalescing plate oil/water separator, hydroxide precipitation, a pressure sand filter, and carbon adsorption. Additions or changes to these unit operations may be necessary depending on the ultimate effluent discharge requirements.

Groundwater 5: Biological Treatment (GW5)

The advantage of biological treatment techniques is the degradation of organics to harmless by-products. Biological treatment covers a wide range of processes that include activated sludge, trickling filters, rotating biological contactors, contact stabilization, and extended aeration. It is difficult to maintain the effectiveness of biological treatment at low concentrations. Also, these systems require more maintenance and monitoring relative to other treatment alternatives.

Groundwater 6: UV Oxidation (GW6)

Ultraviolet-light used in conjunction with an oxidizing agent such as ozone and/or hydrogen peroxide is an effective treatment method for a wide range of organic chemicals. This system offers the advantage of detoxifying contaminants through chemical decomposition rather than transferring them to another media. However incomplete oxidation will generate other organic compounds. The destruction rate will vary depending on the compounds. Process variables such as light intensity, detention time, and oxidizer dosage need to be optimized to increase the destruction rate of the target compounds. The cost of power for operating a UV/oxidation system is significant. The system is subject to fouling and maintenance costs will also be high relative to other technologies. Pretreatment of the groundwater by precipitation/filtration to remove the solids will improve the process efficiency. Although this oxidation process has been used at similar sites for remediation, a treatability study is required to determine its effectiveness at the HAA sites.

Groundwater 7: In-situ Air Sparging

Remediation of groundwater with an air sparging system is effective where the contaminants are volatile and the soil above the water table is permeable. It is similar to that of in-situ biostimulation in that air is injected into the groundwater. However the objective of an air sparging system is to strip the contaminants from the groundwater and transfer them to the soil matrix where the contaminants can be extracted using soil vapor

extraction techniques. The sparged air will either remain in the saturated zone and is captured by the groundwater containment system (i.e., pumping) or pass into the vadose zone where it percolates to the surface (if shallow groundwater) or is captured by the soil vapor extraction system. In order to control the migration of contaminants, a groundwater pump and soil vapor extraction system would be integral to the overall remediation at the site. A secondary benefit of air sparging is the stimulation of the aerobic microorganisms which accelerate biodegradation. The radius of influence around an injection well can be significantly limited by tight soil formations and numerous wells may be needed.

3.2 SCREENING OF SOIL REMEDIAL ACTION ALTERNATIVES

Each alternative has been screened to determine its effectiveness, implementability and cost for each of the HAA sites. The preliminary screening of soil remedial alternatives for each site, assuming the Development Option, is presented in Table 3.3. The screening of remedial alternatives for the Wetland Option is discussed in Section 5. As discussed earlier, the no action alternative is retained for each site as a baseline. Table 3.4 is a summary of retained remedial alternatives for each site assuming the Development Option. Following is a site by site discussion of the screening process.

3.2.1 Site 1: POL Area

The POL area has moderate concentrations of TPH in soil (503 mg/kg maximum concentration detected), primarily around the locations of the former UST and fuel transfer line. Contamination above 100 mg/kg was detected in soils between 14 and 17 feet bgs. Contamination above 10 mg/kg was detected between 5 and 20 feet bgs.

No action is retained as an alternative for all sites. The alternatives involving excavation, namely S6, S7, S8, S9, S11, and S12 were eliminated because of the depth of contamination. Capping (S2) was difficult to implement because of the large area involved. In-situ soil vapor extraction (S5) was eliminated because of the tight soil and rock formations in the subsurface would make this technology difficult and less effective. In-situ soil flushing (S3) and in-situ soil bioremediation (S4) alternatives were retained. Both of these alternatives are potentially effective, and implementable. The costs are comparable, with the cost of in-situ bioremediation slightly lower. In-situ bioventing (S10) is also retained because the low air flow rate may be achieved in the tight soil formation.

3.2.2 Site 2: Burn Pit

The Burn Pit has two distinct areas which require separate remedial action alternative evaluations: the area beneath the 1½-foot-thick, 125-foot diameter concrete pad; and the area around the perimeter of the pad.

TABLE 3.3
PRELIMINARY SCREENING OF REMEDIAL ALTERNATIVES FOR SOIL DEVELOPMENT OPTION - HAMILTON ARMY AIRFIELD

Site/Alternative	Effectiveness	Implementability	Cost(1)	Retained	Eliminated
Site 1: POL AREA					
S1-No Action	No	Yes	Low	x	
S2-Capping	Yes	Difficult	Low		x
S3-In-situ Soil Flushing	Maybe	Yes	Medium	x	
S4-In-situ Bioremediation	Maybe	Yes	Low	x	
S5-In-situ Soil Vapor Extraction	No	No	Low		x
S6-Biological Treatment	Yes	Difficult	Medium		x
S7-Solidification/Stabilization	No	Difficult	Medium		x
S8-Low Temp. Desorption	Yes	Difficult	Medium		x
S9-Thermal Destruction	Yes	Difficult	High		x
S10-In-Situ Bioventing	Maybe	Yes	Low	X	
S11-Chemical Oxidation	No	Difficult	Medium		x
S12-Soil Washing	Yes	Difficult	High		x
Site 2: BURN PIT(2)					
S1-No Action	No	Yes	Low	x	
S2-Capping	No	Yes	Low		x
S3-In-situ Soil Flushing	No	Yes	Medium		x
S4-In-situ Bioremediation	Maybe	Yes	Low	x	
S5-In-situ Soil Vapor Extraction	Maybe	Yes	Low	x	
S6-Biological Treatment	Yes	Yes	Medium	x	
S7-Solidification/Stabilization	No	Yes	Medium		x
S8-Low Temp. Desorption	Yes	Yes	Medium	x	
S9-Thermal Destruction	Yes	Yes	High		x
S10-In-Situ Bioventing	Maybe	Yes	Low	x	
S11-Chemical Oxidation	Yes	Yes	Medium		x
S12-Soil Washing	Yes	Yes	High		x
Site 3: REVETMENT AREA					
S1-No Action	Yes	Yes	Low	x	
S2-Capping	Yes	Yes	High		x
S3-In-situ Soil Flushing	Maybe	Yes	Medium		x
S4-In-situ Bioremediation	Maybe	Yes	Low		x
S5-In-situ Soil Vapor Extraction	Maybe	Yes	Medium		x
S6-Biological Treatment	Yes	Yes	Low	x	
S7-Solidification/Stabilization	No	Yes	Medium		x
S8-Low Temp. Desorption	Yes	Yes	Medium	x	
S9-Thermal Destruction	Yes	Yes	High		x
S10-In-Situ Bioventing	Maybe	Yes	Low		x
S11-Chemical Oxidation	Yes	Yes	Medium		x
S12-Soil Washing	Yes	Yes	High		x

(1) Cost comparison ratings (i.e., high, medium, low) are relative costs for specific site conditions.

(2) This site is divided into two or more sub-areas of contamination because of contaminant or site characteristics. Therefore, alternatives retained for this site may not apply to all sub-areas of contamination.

TABLE 3.3 (continued)

Site/Alternative	Effectiveness	Implementability	Cost(1)	Retained	Eliminated
Site 4: PUMP STATION(2)					
S1-No Action	No	Yes	Low	x	
S2-Capping	No	Yes	Medium		x
S3-In-situ Soil Flushing	No	Yes	Medium		x
S4-In-situ Bioremediation	Maybe	Yes	Low		x
S5-In-situ Soil Vapor Extraction	No	Yes	Low		x
S6-Biological Treatment	Yes	Yes	Low	x	
S7-Solidification/Stabilization	Yes	Yes	Medium	x	
S8-Low Temp. Desorption	Yes	Yes	Medium	x	
S9-Thermal Destruction	Yes	Yes	High	x	
S10-In-situ Bioventing	No	Yes	Low		x
S11-Chemical Oxidation	Yes	Yes	Medium	x	
S12-Soil Washing	No	Yes	High	x	
Site 5: FORMER SEWAGE TREATMENT PLANT (FSTP)(2)					
S1-No Action	No	Yes	Low	x	
S2-Capping	No	Yes	Low		x
S3-In-situ Soil Flushing	No	Yes	Medium		x
S4-In-situ Bioremediation	No	Yes	Low		x
S5-In-situ Soil Vapor Extraction	No	Yes	Low		x
S6-Biological Treatment	No	Yes	Low		x
S7-Solidification/Stabilization	Yes	Yes	Medium	x	
S8-Low Temp. Desorption	No	Yes	Medium		x
S9-Thermal Destruction	Yes	Yes	High	x	
S10-In-situ Bioventing	No	Yes	Low		x
S11-Chemical Oxidation	Yes	Yes	Medium	x	
S12-Soil Washing	Yes	Yes	High	x	
Site 6: EAST LEVEE LANDFILL					
S1-No Action	Yes	Yes	Low	x	
S2-Capping	No	Yes	Low		x
S3-In-situ Soil Flushing	No	Yes	Medium		x
S4-In-situ Bioremediation	No	Yes	Low		x
S5-In-situ Soil Vapor Extraction	No	Yes	Low		x
S6-Biological Treatment	Yes	Yes	Low	x	
S7-Solidification/Stabilization	No	Yes	Medium		x
S8-Low Temp. Desorption	Yes	Yes	Medium	x	
S9-Thermal Destruction	No	Yes	High		x
S10-In-situ Bioventing	No	Yes	Low		x
S11-Chemical Oxidation	No	Yes	Medium		x
S12-Soil Washing	Yes	Yes	High		x

(1) Cost comparison ratings (i.e., high, medium, low) are relative costs for specific site conditions.

(2) This site is divided into two or more sub-areas of contamination because of contaminant or site characteristics, therefore, alternatives retained for this site may not apply to all sub-areas of contamination.

TABLE 3.3 (continued)

Site/Alternative	Effectiveness	Implementability	Cost[1]	Retained	Eliminated
Site 7: AIRCRAFT MAINTENANCE[2]					
S1-No Action	No	Yes	Low	x	
S2-Capping	No	Yes	Medium	x	
S3-In-situ Soil Flushing	No	Yes	Medium		x
S4-In-situ Bioremediation	No	Yes	Low		x
S5-In-situ Soil Vapor Extraction	No	Yes	Low		x
S6-Biological Treatment	Yes	Yes	Low	x	
S7-Solidification/Stabilization	Yes	Yes	Medium	x	
S8-Low Temp. Desorption	Yes	Yes	Medium	x	
S9-Thermal Destruction	Yes	Yes	High	x	
S10-In-situ Bioventing	No	Yes	Low		x
S11-Chemical Oxidation	Yes	Yes	Medium		x
S12-Soil Washing	Yes	Yes	High	x	
Site 8: FUEL LINES					
S1-No Action	Yes	Yes	Low	x	
S2-Capping	Yes	Yes	Medium		x
S3-In-situ Soil Flushing	No	Yes	Medium		x
S4-In-situ Bioremediation	No	Yes	Low		x
S5-In-situ Soil Vapor Extraction	No	Yes	Low		x
S6-Biological Treatment	Yes	Yes	Low	x	
S7-Solidification/Stabilization	No	Yes	Medium		x
S8-Low Temp. Desorption	Yes	Yes	Medium	x	
S9-Thermal Destruction	Yes	Yes	High		x
S10-In-situ Bioventing	No	Yes	Low		x
S11-Chemical Oxidation	Yes	Yes	Medium		x
S12-Soil Washing	Yes	Yes	High		x
Site 9: BUILDING 442 AST[2]					
S1-No Action	Yes	Yes	NA	x	
S2-Capping	NA	NA	NA		x
S3-In-situ Soil Flushing	NA	NA	NA		x
S4-In-situ Bioremediation	NA	NA	NA		x
S5-In-situ Soil Vapor Extraction	NA	NA	NA		x
S6-Biological Treatment	NA	NA	NA		x
S7-Solidification/Stabilization	NA	NA	NA		x
S8-Low Temp. Desorption	NA	NA	NA		x
S9-Thermal Destruction	NA	NA	NA		x
S10-In-situ Bioventing	NA	NA	NA		x
S11-Chemical Oxidation	NA	NA	NA		x
S12-Soil Washing	NA	NA	NA		x
Site 10: TRANSFORMERS	Remove transformers containing over 50 ppm PCB				

(1) Cost comparison ratings (i.e., high, medium, low) are relative costs for specific site conditions.

(2) This site is divided into two or more sub-areas of contamination because of contaminant or site characteristics, therefore, alternatives retained for this site may not apply to all sub-areas of contamination.

TABLE 3.4

RETAINED REMEDIAL ALTERNATIVES FOR DETAILED EVALUATION DEVELOPMENT OPTION - HAMILTON ARMY AIRFIELD

Site and Media of Concern		Alternatives Retained for Detailed Evaluation
Site 1:	POL Area	
	Soil	S1, S3, S4, S10
	Groundwater	GW1, GW2, GW4, GW5
Site 2:	Burn Pit	
	Soil	
	Beneath Pad	S1, S4, S5, S6, S10
	Perimeter of Pad	S1, S6, S8, S10
	Groundwater	GW1
Site 3:	Revetment Area	
	Soil	
	Engine Test Pad	S1, S6, S8
	Revetment Pads	S1, S6, S8
	Groundwater	GW1
Site 4:	Pump Station	
	Soil and Sediment	
	AST Sites	S1, S6, S8, S6/S7, S8/S7, S9/S7, S11/S7
	Stockpile	S1, S6, S8
	Sediment	S1, S6/S7, S8/S7, S9/S7, S11/S7, S12
	Groundwater	GW1
Site 5:	Former Sewage Treatment Plant	
	Soil and Sediment	S1, S9/S7, S11/S7, S12
	Groundwater	GW1, GW4
Site 6:	East Levee Landfill	
	Soil	S1, S6, S8
	Groundwater	GW1

Legend:

S1-No Action
S2-Capping
S3-In-situ Soil Flushing
S4-In-situ Bioremediation
S5-In-situ Soil Vapor Extraction
S6-Biological Treatment
S7-Solidification/Stabilization
S8-Low Temp. Desorption
S9-Thermal Destruction
S10-In-situ Bioventing
S11-Chemical Oxidation
S12-Soil Washing
GW-1 No Action
GW-2 In-situ Biostimulation
GW-3 Air Stripping and Carbon Adsorption
GW-4 Carbon Adsorption
GW-5 Biological Degradation
GW-6 UV Oxidation
GW-7 In-situ Air Sparging

TABLE 3.4 (continued)

Site and Media of Concern		Alternatives Retained for Detailed Evaluation
Site 7:	Aircraft Maintenance and Storage Area	
	Soil	S1, S2, S7, S6/S7, S6/S12, S8/S7, S8/S12, S12,
	Sediment	S1, S6/S7, S8/S7, S9/S7
	Groundwater	GW1, GW4, GW5, GW6
Site 8:	Fuel Lines	
	Soil	S1, S6, S8
Site 9:	Building 442 AST	
	Soil	S1
Site 10:	Transformer and Other Oil Filled Items	NA

Legend:

S1-No Action
S2-Capping
S3-In-situ Soil Flushing
S4-In-situ Bioremediation
S5-In-situ Soil Vapor Extraction
S6-Biological Treatment

S7-Solidification/Stabilization
S8-Low Temp. Desorption
S9-Thermal Destruction
S10-In-situ Bioventing
S11-Chemical Oxidation
S12-Soil Washing

GW-1 No Action
GW-2 In-situ Biostimulation
GW-3 Air Stripping and Carbon Adsorption
GW-4 Carbon Adsorption
GW-5 Biological Degradation
GW-6 UV Oxidation

NA-Not Applicable

Beneath Pad

Soil samples collected at the intersection of the expansion joints beneath the concrete pad (1 to 1.5 foot thick) had maximum TPH concentrations of 1,920 mg/kg at a depth of 2 feet and decreased gradually to 17.3 mg/kg at a depth of 7 feet . Assuming that the extent of contamination is consistent laterally, approximately 3,400 cubic yards of soil require remediation. The estimated large volume of contamination and the concrete pad makes in-situ alternatives more attractive than excavation. The highest contaminant concentrations (1,920 mg/kg TPH) were found at a depth of 2 feet. The shallow soil under the pad is fill material which is more permeable than the underlying Bay Mud. Thus it is potentially amenable to in-situ bioventing (S10), in-situ soil vapor extraction (S5) and in-situ bioremediation (S4). One disadvantage is that the fill material that underlies most of the pad is nonhomogeneous; therefore, cleanup would not be uniform. The in-situ soil flushing alternative was rejected because the highest contamination is shallow, and soil flushing might transport the contamination to less contaminated depths.

It is uncertain if any of the in-situ technologies can achieve 10 mg/kg TPH and a treatability study would be needed to confirm effectiveness of the technology for the specific site. Although the excavation of the concrete pad as well as contaminated soil is very expensive, excavation and biological treatment (S6) was retained and would likely achieve the 10 mg/kg TPH remediation goal where soil contamination is localized near the expansion joints. Biological treatment was the only ex-situ alternative retained because if excavation is used, biological treatment would be the most cost-effective method of treating TPH.

Perimeter of Pad

Soil contamination at the perimeter of the pad is variable and predominantly found in the surface soil, therefore all the in-situ alternatives were eliminated. The most effective alternatives for surface TPH contamination are to excavate the soil and treat by biological treatment (S6), low temperature thermal desorption (S8), or chemical oxidation (S11). Soil washing (S12) was rejected because of higher costs. The contamination is TPH so that solidification/stabilization (S7) is not effective and thermal destruction (S9) is too expensive. Samples from MW-103 detected TPH contamination down to 10.5 feet below surface.

3.2.3 Site 3: Revetment Area

Surface and shallow soil contamination in the Revetment Area were found at a few sporadic locations around the perimeter of the revetment pads and the engine test pad. TPH contaminations were mostly in surface samples, and low concentrations of SVOCs (0.6 mg/kg) were detected as deep as 6 feet.

Since contamination is localized and sporadic, excavation and treatment alternatives are the more cost effective than in-situ alternatives. Biological treatment (S6) and low temperature thermal desorption (S8) alternatives are retained for final evaluation. Both (S6) and (S8) are considered more cost-effective than chemical oxidation (S11) so that (S11) is eliminated. Thermal destruction (S9) and soil washing (S12) were rejected because their costs are much higher.

3.2.4 Site 4: Pump Station

The Pump Station has two areas of soil contamination and one area of sediment contamination.

AST Sites (soil)

Surface soils near ASTs exhibit localized high concentrations of TPH ranging as high as 332,000 mg/kg near AST-6. There were also elevated levels of benzo[a]pyrene (6.2 mg/kg) and beta-benzenehexachloride (46.1 mg/kg). Since contamination is surfacial, in-situ alternatives are rejected. Biological treatment, low temperature thermal desorption and thermal destruction are all effective treatments for TPH. Biodegradation is effective for TPH, but beta-benzene hexachloride is not readily biodegradable. Both compounds do not volatilize easily. Because of these factors, thermal destruction (S9) is considered the most effective remedial alternatives for the soils. Biological treatment (S6), low temperature thermal desorption (S8), and chemical oxidation (S11) alternatives are retained, but treatability studies should be conducted if these alternatives are selected. Soil washing (S12) would transfer contaminants to wastewater which would require additional treatment prior to disposal.

Stockpile (soil)

Surface soil samples were found to contain elevated levels of TPH only. Biological treatment (S6) and low temperature thermal desorption (S8) are by far the most effective alternatives. For TPH contaminated soils, the chemical oxidation alternative would cost most but would not be more effective than the S6 and S8. No excavation is associated with these alternatives since the soils are stockpiled.

Sediment

Sediments had TPH at concentrations as high as 2,690 mg/kg. It also had low levels of pesticides DDT and DDD at 0.25 mg/kg and 3.03 mg/kg respectively. Elevated levels of metals were also found. Contamination is shallow, therefore all in-situ alternatives are not effective. In-situ vitrification is not effective for soils containing high levels of organic contaminant. DDT and DDD are not readily biodegradable although there are unpublished reports of rapid transformation of DDT to DDD in anaerobic environment (EPA, 1990b). Similar to AST soils, thermal destruction (S9) is the most effective technology. Bioremediation (S6), chemical oxidation (S11), and low temperature thermal desorption (S8) alternatives are retained but treatability studies should be conducted if these alternatives are selected. In addition, because of the elevated concentrations of heavy metals these alternatives have to be conducted with the solidification/stabilization alternative (S7). Soil washing (S12) was retained because this single alternative can remove both organic and non-organic contaminants.

3.2.5 Site 5: Former Sewage Treatment Plant (FSTP)

Contaminants at the Former Sewage Treatment Plant include PCBs, pesticides, VOCs, SVOCs, and metals. Organic contamination is predominantly within the upper few feet of soil. PCB at levels that exceed the PRGs, and elevated concentrations of DDT, DDE, and DDD were detected in shallow samples from the former sludge drying beds. The

estimated volume of contamination is large. Soils and sediment present low to high risk to health and the environment. Alternatives retained for further evaluation are chemical oxidation (S11), thermal destruction (S9), soil washing (S12) and solidification and stabilization (S7). All other alternatives are not effective for the contaminants on site.

3.2.6 Site 6: East Levee Landfill

Organic contaminant concentrations in subsurface soils at the East Levee Landfill are very low, and concentrations of heavy metals are slightly within background levels although the public health risk evaluation indicate low to high risk for a scenario of residential development but low risk for present use conditions. No environmental risks were identified in the ecological risk assessment. Previous investigations conducted in 1987 found four detections of TPH (motor oil) at or below 110 mg/kg out of 36 soil samples. TPH and TPHjf were not detected. TPHd was detected at a low concentration in one sample (Woodward-Clyde 1987). The EI conducted in 1991 found no significant VOCs or SVOCs contamination [3 mg/kg bis(2-ethylhexylphthalate)], and no elevated concentrations of metals. TPH was not evaluated during the EI (Engineering-Science 1993), because fuel hydrocarbon contamination was considered to be insignificant based on the Woodward-Clyde (1987) study. Retained alternatives are biological treatment (S6) and low temperature thermal desorption (S8). These two alternatives are more cost effective than other ex-situ alternatives for TPH. All in-situ alternatives are eliminated because contamination is in shallow soils.

3.2.7 Site 7: Aircraft Maintenance Area

The Aircraft Maintenance Area has two areas: soil and sediment contamination.

Soil

TPH was detected only in shallow soils down to 2.5 feet below the surface, with a maximum level of 4,650 mg/kg at two feet at test pit AM-TP-1. In the same sample, the concentration of tentatively identified compounds (TICs) in the volatile range is 6,700 mg/kg. Additional evaluation of the TICs may be necessary to implement the selected alternatives. Technologies retained to treat soils containing TPH and TICs are excavation and biotreatment (S6), low temperature thermal desorption (S8), and soil washing (S12). Soil washing was retained because it can remediate organics and metals. All other ex-situ alternatives are less cost-effective. In-situ technologies were dismissed since the contamination was not detected deep in the subsurface.

Elevated levels of beryllium were detected throughout the soils at the Aircraft Maintenance Area at concentrations that exceeded both the PRG (0.149 mg/kg) and the background upper limit (1.08 mg/kg). Analytical data seems to indicate that elevated levels of beryllium are primarily in the shallow soils between 1 to 2 feet deep, which reportedly are imported fill material of unknown origin used to grade the site prior to development as an Aircraft Maintenance Area. Remediation would require the removal and treatment of the backfill down to PRGs or capping. Alternatives retained to treat for metals include solidification/stabilization (S7) and soil washing (S12). These technologies were combined with technologies to treat for TPH in soil to develop

alternatives to the site. In addition, soil solidification/stabilization (S7) and soil washing (S12) were each retained as stand alone alternatives to treat both TPH and metals.

Sediment

The sediment at the Aircraft Maintenance Area is enclosed in concrete vaults and can easily be removed and treated separately from the soils at the site.

The sediment contaminant profile is uniquely different from the soil. TPH ranges from 230 to 2,500 mg/kg and is present in sediment samples tested. Lead was detected in all samples analyzed, but only exceeded the 535 mg/kg cleanup criteria in one. Lead very likely would be an issue in disposing of the sediment because of the impact on RCRA land disposal criteria. Beryllium and arsenic were detected at concentrations that exceeded background levels in several sediment samples as well. Benzo[A]pycene was detected in four (of eight sites) at levels that exceed PRGs. Remedial alternatives retained to treat the sediments are excavation and biotreatment (S6), low temperature thermal desorption (S8), or thermal destruction (S9). These technologies would be followed by either solidification/stabilization (S7) or soil washing (S12) to treat the metal contamination. Soil washing (S12) was also considered as a stand alone alternative to treat both TPH and metals.

3.2.8 Site 8: Fuel Lines

Fuel contaminant concentrations between 10 mg/kg and 264 mg/kg were identified in shallow soil samples (approximately 2 feet deep) throughout most of the site. For shallow soil contamination, all in-situ alternatives are not effective and therefore rejected. The volume of soil contamination is expected to be relatively high, therefore off-site thermal destruction (S9) was rejected because of high costs. Retained alternatives include biological treatment (S6), and low temperature thermal desorption (S8). These two alternatives are generally more cost-effective than other ex-situ alternatives for TPH contaminants.

3.2.9 Site 9: Building 442 AST

No soil contamination was found at this site.

3.2.10 Site 10: Transformer and Oil-containing Items

Seven of 54 transformer and oil-containing items showed PCB concentrations above 50 ppm. We recommend that all items containing PCB above 50 ppm be removed from the site and appropriately treated and disposed, in conformance to TSCA.

3.3 SCREENING OF GROUNDWATER REMEDIAL ALTERNATIVES

Each groundwater alternative has been screened to determine its applicability, effectiveness, implementability and cost for each of the HAA sites. The preliminary screening of alternatives for each site is presented in Table 3.5. The no action alternative is retained at all sites as a baseline. The retained alternatives for each site are summarized in Table 3.4.

TABLE 3.5
PRELIMINARY SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER
Hamilton Army Airfield

Site/Alternative	Effectiveness	Implementability	Cost(1)	Retained	Eliminated
Site 1: POL AREA					
G1-No Action	No	Yes	Low	x	
G2-In-situ Biostimulation	Yes	Maybe	Low	x	
G3-Air Stripping and Carbon Adsorption	Yes	Yes	Medium		x
G4-Carbon Adsorption	Yes	Yes	Low	x	
G5-Biological Treatment	Yes	Yes	Low	x	
G6-UV/Oxidation	No	Yes	High		x
G7-In-situ Air Sparging	Yes	Yes	High		x
Site 2: BURN PIT					
G1-No Action	No	Yes	Low	x	
G2-In-situ Biostimulation	Yes	Yes	Low		x
G3-Air Stripping and Carbon Adsorption	Yes	Yes	Medium		x
G4-Carbon Adsorption	Yes	Yes	Low		x
G5-Biological Treatment	Yes	Yes	Low		x
G6-UV/Oxidation	Yes	Yes	High		x
G7-In-situ Air Sparging	Yes	Yes	High		x
Site 3: REVETMENT AREA					
G1-No Action	Yes	Yes	NA	x	
G2-In-situ Biostimulation	NA	NA	NA		x
G3-Air Stripping and Carbon Adsorption	NA	NA	NA		x
G4-Carbon Adsorption	NA	NA	NA		x
G5-Biological Treatment	NA	NA	NA		x
G6-UV/Oxidation	NA	NA	NA		x
G7-In-situ Air Sparging	NA	NA	NA		x

(1) Cost comparison ratings (i.e., high, medium, low) are relative costs for specific site conditions.

NA = Not Applicable

TABLE 3.5 (continued)

Site/Alternative	Effectiveness	Implementability	Cost(1)	Retained	Eliminated
Site 4: PUMP STATION					
G1-No Action	Yes	Yes	NA	x	
G2-In-situ Biostimulation	NA	NA	NA		x
G3-Air Stripping and Carbon Adsorption	NA	NA	NA		x
G4-Carbon Adsorption	NA	NA	NA		x
G5-Biological Treatment	NA	NA	NA		x
G6-UV/Oxidation	NA	NA	NA		x
G7-In-situ Air Sparging	NA	NA	NA		x
Site 5: FORMER SEWAGE TREATMENT PLANT (FSTP)					
G1-No Action	No	Yes	Low	x	
G2-In-situ Biostimulation	No	No	Low		x
G3-Air Stripping and Carbon Adsorption	Yes	Yes	Medium		x
G4-Carbon Adsorption	Yes	Yes	Low	x	
G5-Biological Treatment	No	Yes	Low		x
G6-UV/Oxidation	No	Yes	High		x
G7-In-situ Air Sparging	No	No	High		x
Site 6: EAST LEVEE LANDFILL					
G1-No Action	Yes	Yes	NA	x	
G2-In-situ Biostimulation	NA	NA	NA		x
G3-Air Stripping and Carbon Adsorption	NA	NA	NA		x
G4-Carbon Adsorption	NA	NA	NA		x
G5-Biological Treatment	NA	NA	NA		x
G6-UV/Oxidation	NA	NA	NA		x
G7-In-situ Air Sparging	NA	NA	NA		x

(1) Cost comparison ratings (i.e., high, medium, low) are relative costs for specific site conditions.

NA = Not Applicable

TABLE 3.5 (continued)

Site/Alternative	Effectiveness	Implementability	Cost(1)	Retained	Eliminated
Site 7: AIRCRAFT MAINTENANCE					
G1-No Action	No	Yes	Low	x	
G2-In-situ Biostimulation	No	Yes	Low		x
G3-Air Stripping and Carbon Adsorption	Yes	Yes	Medium		x
G4-Carbon Adsorption	Yes	Yes	Low	x	
G5-Biological Treatment	Yes	Yes	Low	x	
G6-UV/Oxidation	Yes	Yes	High	x	
G7-In-situ Air Sparging	No	Yes	High		x
Site 8: FUEL LINES					
G1-No Action	Yes	Yes	NA	x	
G2-In-situ Biostimulation	NA	NA	NA		x
G3-Air Stripping and Carbon Adsorption	NA	NA	NA		x
G4-Carbon Adsorption	NA	NA	NA		x
G5-Biological Treatment	NA	NA	NA		x
G6-UV/Oxidation	NA	NA	NA		x
G7-In-situ Air Sparging	NA	NA	NA		x
Site 9: BUILDING 442 AST					
G1-No Action	Yes	Yes	NA	x	
G2-In-situ Biostimulation	NA	NA	NA		x
G3-Air Stripping and Carbon Adsorption	NA	NA	NA		x
G4-Carbon Adsorption	NA	NA	NA		x
G5-Biological Treatment	NA	NA	NA		x
G6-UV/Oxidation	NA	NA	NA		x
G7-In-situ Air Sparging	NA	NA	NA		x

(1) Cost comparison ratings (i.e., high, medium, low) are relative costs for specific site conditions.

NA = Not Applicable

3.3.1 Site 1: POL Area

Maximum concentrations of contaminants found at the POL Area are TPH (14,000 µg/L), VOCs (4,720 µg/L) and SVOCs (1,474 µg/L). The low permeability of the soils and relatively flat hydraulic gradient result in very slow migration of the contaminant plume. Groundwater pumping will be extremely difficult as indicated by the field observed hydraulic conductivity of $1.2x10^{-7}$ feet per second.

Six of the seven groundwater alternatives are effective and implementable. In-situ biostimulation (GW2) is retained because it is effective on the contaminants of concern and is relatively low in cost; however, operation may be somewhat difficult to control because of low permeability of the soil. Carbon adsorption (GW3) is cost effective for the low organic concentration and flow rate expected at the POL site. Biological treatment (GW5) is a cost effective alternative. Filtration (GW3) is retained because it is a pretreatment step for the other alternatives. Air stripping with liquid phase carbon adsorption (GW3) is rejected because carbon adsorption alone is equally effective, construction and operation is associated with one operation unit. Air stripping with carbon adsorption is usually the more effective alternative if the contamination consists of mostly of VOCs so that the carbon is used only to polish small quantities of less volatile organics (1,280 µg/L SVOCs). The groundwater at POL contains significant levels of less volatile organics so that the carbon adsorption unit would experience significant loading. UV/oxidation (GW6) was dismissed because it is not applicable to the suite of analytes requiring treatment. In-situ air sparging (GW7) was rejected because this technology needs to be implemented in conjunction with soil vapor extraction (SVE). SVE is not feasible because of the proliferation of bedrock and tight soils throughout the area.

3.3.2 Site 2: Burn Pit

The only analyte that requires remediation of the groundwater at the Burn Pit is TPH in order to comply with the SFRWQCB nondegradational policy. Three of five samples exceed the CRL of 100 ug/L with a maximum concentration of 140 ug/L. These results are based on one round of sampling conducted in 1991 (Engineering Science 1993). Since additional sampling is needed to determine if a trend exists and to track seasonal variations, only the no action alternative (GW1) was retained.

3.3.3 Site 5: Former Sewage Treatment Plant

Four analytes in the groundwater at the Former Sewage Treatment Plant exceed ARARs: benzene, dichlorobenzene, phenol, and antimony. Groundwater in the area is shallow and collector trenches would be capable of collecting the groundwater. The flow rate may vary from 0 to 10 gpm. Two groundwater alternatives are effective and implementable: no action (GW1) and precipitation followed by carbon adsorption (GW4). The groundwater is brackish at the Former Sewage Tretment Plant contains high concentrations of minerals. Precipitation would reduce the mineral content of the groundwater. Carbon adsorption is cost effective at low flow rates and at low concentrations of organic contamination. In-situ biostimulation (GW2) and biological treatment (GW5) were dismissed because dichlorobenzene is toxic to microorganisms

(Paterson 1985). Air stripping followed by liquid phase carbon adsorption (GW4) is rejected because carbon adsorption alone is equally effective. UV/oxidation (GW6) is not effective in treating phenols and was rejected. Air sparging (GW7) was rejected because this technology needs to be implemented in conjunction with soil vapor extraction (SVE). SVE is not feasible since the groundwater depth is very shallow.

3.3.4 Site 7: Aircraft Maintenance Area

Three analytes require treatment at the Aircraft Maintenance Area: benzene, beryllium, and chromium. Four of the seven groundwater alternatives are effective and implementable, including the no action alternative (GW1). Precipitation/filtration (GW3) is needed as a pretreatment step since the groundwater underlying the site is brackish and contains high concentrations of minerals. Carbon Adsorption (GW4), Biological Treatment (GW5) and UV/oxidation (GW6) were all retained to treat benzene. In situ technologies, biostimulation (GW2) and air sparging (GW7) were dismissed because they cannot remediate the metal contamination in the groundwater. Air stripping with liquid phase carbon adsorption is dismissed since carbon adsorption alone is equally effective for benzene at low flow rates. The hydraulic conductivity at the site is approximately $8x10^{-6}$ and groundwater extraction is expected to be extremely difficult.

3.3.5 Other Sites

Other sites had minor groundwater contamination but contaminant concentrations detected were all below the available ARARs. These sites include the following:

Site 3 - Revetment Area
Site 4 - Pump Station
Site 6 - East Levee Landfill

3.3.6 Discharge of Treated Water

The three potential discharge routes for treated groundwater retained for detailed evaluation include: 1) Surface water; 2) Publicly-Owned Treatment Works, and; 3) Reinjection or Alluvial groundwater discharge.

Discharges to Surface Water

Effluent discharge to a surface water body is regulated locally by the San Francisco Bay Regional Water Quality Control Board (SFRWQCB). The SFRWQCB requires a facility permit outlining the chemical constituents and removal processes. Surface water bodies near HAA with a potential likelihood of receiving treated effluent are the San Pablo Bay, wetlands along San Pablo Bay, and Pacheco Creek. Discharge to wetlands was selected as the best discharge alternative for groundwater remedial project at Landfill 26, an adjacent site.

The SFRWQCB mandated that before an NPDES permit to discharge is granted the following options must be considered (SFRWQCB 1988):

1. Reclamation of extracted water
2. Discharge to POTW

An effluent reclamation feasibility study must be prepared to show that Option 1 is infeasible. Then in a written letter, the POTW must refuse to accept the treated effluent.

Draft discharge limits negotiated for the Landfill 26 treatment discharge are presented in Table 3.6 (SFRWQCB 1992a). The effluent limits may be changed to reflect SWELs (Appendix I).

Discharges to drinking water sources will have more stringent limits which may exceed ARARs.

Discharge to POTW

The Novato Sanitary Sewer District is the local POTW for HAA. There are no specific pollutant limits for gasoline and fuels. However, Novato Sanitary Sewer District will evaluate proposed discharges on a case-by-case basis. Specific pollutant limits are summarized in Table 3.7.

Alluvial Groundwater Discharge (Reinjection)

Discharging the effluent to the ground or subsurface includes beneficial results. The recovery system effluent may be discharged to recharge wells or used as irrigation water at various locations on the site. On-site reuse of treated water would reduce the site's water supply demands. However on-site reuse can not be evaluated until future site use has been determined. Discharging to the subsurface (reinjection) in strategically placed recharge wells or drains may speed up remediation at the site. Recharge upgradient of the site recovery wells increases local gradients and, therefore, groundwater flow velocities to the pumping recovery wells. Increasing flow by reinjection should decrease the time necessary to complete remediation and could substantially decrease operating and maintenance costs.

Discharge to the ground or recharge to groundwater would require either that the effluent meet the most stringent ARARs or that a risk assessment be prepared. If discharge concentrations exceeded ARARs, the risk assessment would need to confirm that the discharge would result in an acceptable cancer risk. Most of the water recharged upgradient of recovery wells at the site could subsequently be pumped out of the ground by recovery wells, thus avoiding off-site migration. Therefore, a risk assessment may indicate that water with contaminant levels above ARARs could safely be reinjected at the site based on the technical quality of the recharge system design. However, studies conducted at Landfill 26, an adjacent site, indicate that there are no adequate water-bearing bodies underground to receive the discharge. For this reason reinjection into an aquifer is rejected from further consideration.

3.3.7 Discharge of Untreated Water

The discharge of untreated groundwater to the proposed Landfill 26 treatment plant may also be available. The proposed Landfill 26 treatment plant will be a 40 gallons per minute (GPM) system consisting of oil/water separation, sand filtration, metal precipitation, and carbon adsorption. The design influent concentrations for the Landfill 26 treatment plant is presented in Table 3.8.

TABLE 3.6
DRAFT NPDES DISCHARGE LIMITS FOR LANDFILL 26 TREATMENT PLANT[1]

Discharge Parameter	Discharge Limitations (mg/l)[2] Average Monthly	Maximum Daily[3]	Instantaneous Maximum	Monitoring Requirements Measurement Frequency	Sample Type
Flow (MGD)		MO		Daily	Measured
Conductivity		MO		5/week	Grab
TDS		MO		1/week	8-hr comp.
Calcium		MO		1/month	8-hr comp.
Chloride		MO		1/month	8-hr comp.
Sulfate		MO		1/month	8-hr comp.
Sodium		MO		1/month	8-hr comp.
Chemical Oxygen Demand	10	15	20	5/week	Grab
Total Organic Carbon	5	10	15	1/week	Grab
Total Suspended Solids	10	15	20	1/month	8-hr comp.
TPH	15		30	1/month	3 grab/8 hr
pH	Not < 6.0 standard units nor > 9.0 standard units at all times			daily	Grab
Metals					
Aluminum	0.05	0.07	0.10	1/month	8-hr comp.
Antimony	0.003	0.004	0.006	1/month	8-hr comp.
Arsenic	0.02	0.025	0.030	1/month	8-hr comp.
Barium	1.0	1.5	2.0	1/month	8-hr comp.
Chromium	0.05	0.07	0.10	1/month	8-hr comp.
Iron	0.3	0.6	0.7	1/month	8-hr comp.
Lead	0.005	0.01	0.02	1/month	8-hr comp.
Nickel	0.10	0.15	0.20	1/month	8-hr comp.
Silver	0.0023	0.01	0.02	1/month	8-hr comp.
Zinc	5.0	7.0	10.0	1/month	8-hr comp.
Organics					
Benzene	0.005	0.007	0.010	1/month	Grab
Trichloroethene	0.005	0.007	0.010	1/month	Grab
Vinyl Chloride	0.002	0.003	0.004	1/month	Grab
bix(2-Ethylhexyl)phtha	0.004	0.006	0.008	1/month	Grab
Pesticides/PCBs					
4,4'-DDD	0.0001	0.00015	0.0002	1/month	Grab
4,4'-DDE	0.0001	0.00015	0.0002	1/month	Grab
4,4'-DDT	0.0001	0.00015	0.0002	1/month	Grab

(1) These limits may or may not apply to HAA (to be determined by SFRWQCB).

(2) Unless otherwise indicated, these are gross discharge limitations.

(3) MO = Monitoring only.

Source: SFRWQCB 1992a.

TABLE 3.7

DISCHARGE LIMITS FOR NOVATO SANITARY SEWER DISTRICT

Pollutant	Maximum Concentration (mg/l)	Comments
Ammonia	125.0	
Arsenic	0.5	
Boron	1.0	
Cadmium	0.11	
Chromium (total)	1.0	
Copper	1.5	
Lead	0.4	
Mercury	0.1	
Nickel	1.0	
Silver	0.43	
Zinc	2.6	
Cyanide	1.0	
Phenols	5.0	
PAH's (polyaromatic hydrocarbons)	1.0	
TICH (total identifiable chlorinated hydrocarbons)	0.15	
TTO (total toxic organics)		(case-by-case basis)
Other toxic materials		(case-by-case basis)
BOD or TSS	400	(can apply for higher value)
Petroleum soluble fat, oil, grease	200	
TDS	2,420	(at 5,000 gallons/day)
Chloride	480	(at 5,000 gallons/day)

Additional limits include:

- liquid temperature of 60°C (140°F)
- pH between 5.5 and 8.5
- color limitations

TABLE 3.8

LANDFILL 26 TREATMENT PLANT INFLUENT CHARACTERISTICS

Parameter	Estimated Influent Concentration
Total Dissolved Solids (TDS)	2,500
Nitrate-Nitrite as N	1.0
Calcium	200
Chloride	1,000
Sulfate	240
Sodium	600
Chemical Oxygen Demand (COD)	200
Total Organic Carbon (TOC)	50
Total Suspended Soils (TSS)	0
Total Petroleum Hydrocarbons (TPH)	30
pH	7.0
<u>Metals</u>	
Aluminum	12
Antimony	0.03
Arsenic	0.01
Barium	0.40
Boron	1.00
Cadmium	0.01
Chromium	0.02
Copper	0.05
Iron	27.00
Lead	0.10
Magnesium	60.00
Manganese	1.40
Nickel	0.05
Silicon	22.00
Silver	0.01
Zinc	0.28
<u>Organics</u>	
Acetone	0.022
Benzene	0.001
Chlorobenzene	0.006
Methylene Chloride	0.002
Toluene	0.001
Total Xylenes	0.001
Trichloroethene	0.020
Vinyl Chloride	0.005
bix(2-Ethylhexyl)phtha	0.015
1,3-Dichlorobenzene	0.010
Naphthalene	0.020
Phenanthrene	0.010
Phenol	0.020
<u>Pesticides</u>	
4,4'-DDD	0.001
4,4'-DDE	0.001
4,4'-DDT	0.001

Estimated influent concentrations are based on groundwater concentrations observed during previous field investigations.
Source: USACE 1992.

SECTION 4

DEVELOPMENT OPTION
EVALUATION OF SOIL REMEDIAL ALTERNATIVES

The soil and groundwater remediation technologies that passed the screening described in Section 2 are assembled and screened as comprehensive alternatives in Section 3. A sufficient number of alternatives are retained to provide a broad range of possible actions to address the general remediation objectives. This section provides a detailed evaluation of the remedial alternatives that were retained after alternative screening and to select remedies for each site area. The evaluation includes:

- Detailed descriptions and preliminary specifications of each remedial alternative retained, emphasizing the technologies used and the components of each alternative; and
- Detailed analysis of each remedial alternative retained relative to the evaluation criteria established to address CERCLA requirements.

This detailed evaluation of alternatives is completed on a site-by-site basis and includes an analysis of each retained remedial alternative relative to the nine evaluation criteria established to address CERCLA requirements. The nine evaluation criteria are used to conduct a comparative analysis that focuses on the relative performance or applicability of each remedial alternative to site-specific conditions. The nine evaluation criteria are presented below.

Overall protection of human health and the environment: Alternatives are assessed to determine whether they can adequately protect human health and the environment from unacceptable short and long-term risks posed by hazardous substances, pollutants, or contaminants by eliminating, reducing, or controlling exposures.

Compliance with ARARs: Alternatives are assessed to determine whether they attain applicable or relevant and appropriate requirements and meet remedial action objectives. Action specific ARARs include RCRA requirements for land disposal if the soil is excavated.

Long-term effectiveness and permanence: Alternatives are assessed for the long-term effectiveness and permanence they provide including the magnitude of residual risk remaining from untreated waste or treatment residuals. Additionally, the adequacy and reliability of the alternatives is assessed.

Reduction of toxicity, mobility, or volume through treatment: This assessment criteria addresses the degree to which alternatives use recycling or treatment to reduce toxicity, mobility, or volume of the principal hazards posed by the site.

Short-term effectiveness: The short-term impacts of alternatives are assessed to consider risks to the community, site workers, and the environment during implementation of the alternative.

Implementability: The ease or difficulty of implementing the alternative is assessed including technical feasibility, administrative feasibility, and availability of services or materials.

Cost: The costs to implement the alternative are estimated. The cost estimate includes capital costs, operation and maintenance costs, and present value costs.

State acceptance: This assessment provides an evaluation of the state's anticipated position including key concerns related to alternatives and their compliance with ARARs.

Community acceptance: This assessment determines the community preferences for the alternatives.

The last two criteria, state and community acceptance are evaluated in this draft AA as anticipated acceptance, but will be updated in the Final AA to reflect state and community comments on the EI/AA reports.

As described in Section 2.1, the ultimate future use of the HAA property has not been determined at this time. This AA addresses the two potential land use options which will likely result in the greatest exposure to humans and environmental receptors.

These two options are:

> Option 1 - sale to private developer will likely result in the greatest degree of human exposure to contaminants, if the developer converts the property to a residential area.
>
> Option 2 - creation of an artificial wetland will likely present the greatest degree of environmental risk. Flooding would affect the Revetment Area, Burn Pit, Pump Station, Former Sewage Treatment Plant, East Levee Landfill, Aircraft Maintenance Area and the JP-4 fuel line area.

Section 4 is a site-by-site detailed evaluation of the soil remedial alternatives retained after initial screening for the sale to developer option. Section 5 is the evaluation of groundwater remedial alternatives which is also associated with the Development Option. Section 6 is the detailed evaluation of remedial alternatives assuming the Wetland Option.

Table 3.4 is a summary of the alternatives retained for each of the nine sites. A total of twelve soil remedial alternatives have been retained after evaluation in preliminary screening. These alternatives include:

- S1: No Action;
- S2: Capping;

- S3: In-situ Soil Flushing;
- S4: In-situ Bioremediation;
- S5: In-situ Soil Vapor Extraction;
- S6: Excavation and Biological Treatment;
- S7: Excavation and Solidification/Stabilization;
- S8: Excavation and Low Temperature Thermal Desorption;
- S9: Excavation and Off-site Thermal Destruction;
- S10: In-situ Bioventing;
- S11: Excavation and Chemical Oxidation; and
- S12: Excavation and Soil Washing.

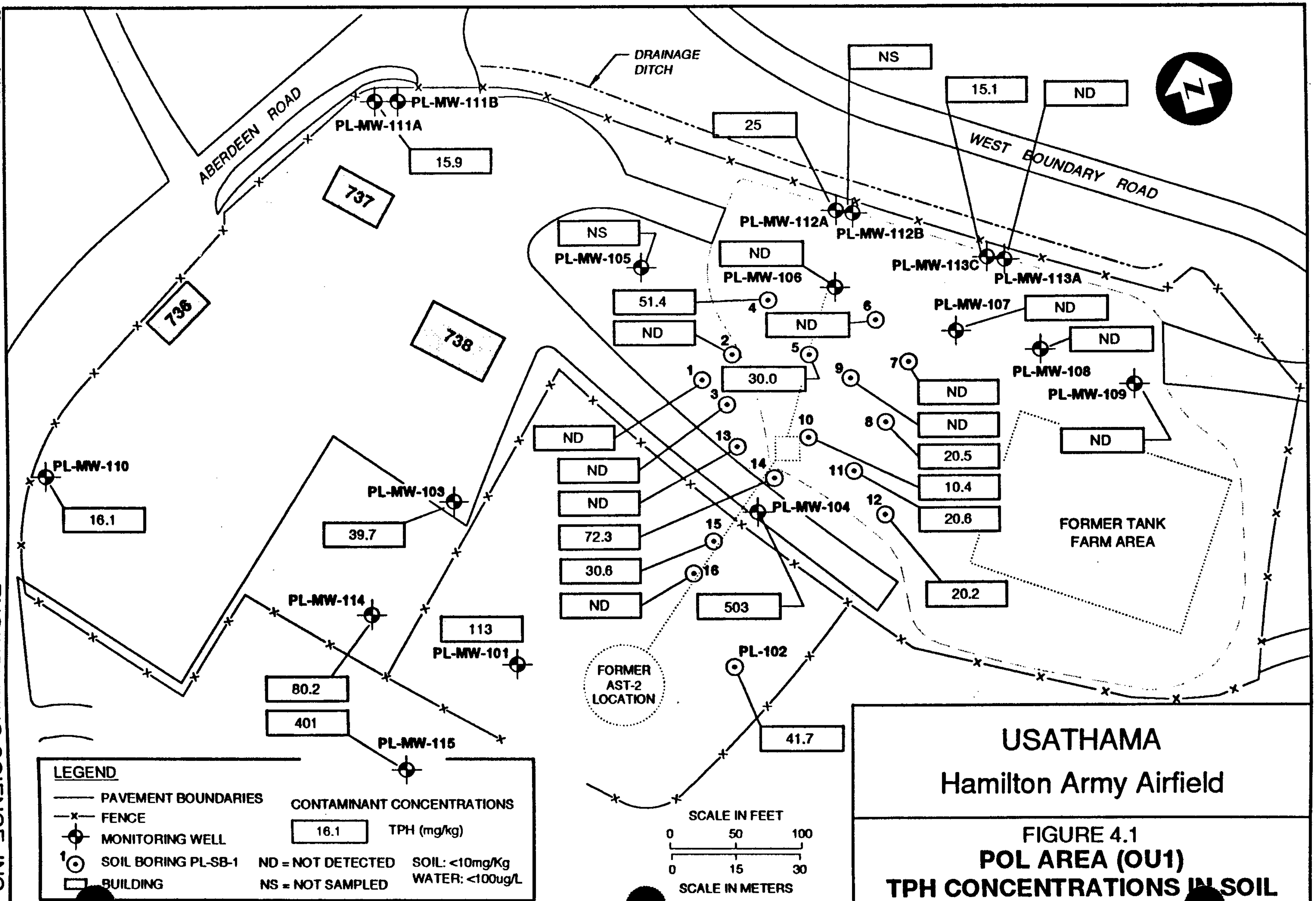
4.1 SITE 1: POL AREA

Soil contamination at the POL Area is characterized by moderate concentrations of TPH (503 mg/kg maximum concentration detected at 17 feet below ground surface) around the location of the former site of AST-2 and a recently removed fuel supply line that led to the tank farm. The subsurface soil matrix at POL is predominantly fractured rock and other low permeability soil formations with a hydraulic conductivity of 1.2×10^{-7} ft/sec. Excavating the soil to a cleanup goal of 10 mg/kg is not practical and it is unlikely that in-situ technologies can attain 10 mg/kg TPH cleanup goal in fractured rock or tight soil formations. Instead of the 10 mg/kg cleanup goal selected for all other HAA sites, a cleanup goal of 100 mg/kg TPH was selected. All of the contamination detected above 100 mg/kg of TPH in this area was in the interval between 14 and 17 feet bgs in both rock and soil. No other analytes exceeded PRGs or other cleanup goals. The human health risk at the site is less than 1×10^{-6}. The ecological risk also did not identify additional chemicals of concern. The volumes of contaminated soil and rock with TPH concentrations above 100 mg/kg are estimated at approximately 5,190 cubic yards of soil and 15,300 cubic yards of rock. The area of contamination is shown in Figure 1.3. Contaminated rock accounts for 75 percent of the estimated volume exceeding 100 mg/kg TPH at the POL sites. Figure 4.1 is an area map which shows the locations of TPH concentrations at the POL site.

Remedial alternatives retained for this site area include:

- S1: No Action;
- S3: In-situ Soil Flushing;
- S4: In-situ Bioremediation; and
- S10: In-situ Bioventing.

The following four subsections present the evaluation of each alternative relative to the nine evaluation criteria. Additionally, Figure 4.2 presents the summary of the detailed analysis of the remedial alternatives retained relative to the evaluation criteria.



USATHAMA

Hamilton Army Airfield

FIGURE 4.1

POL AREA (OU1)

TPH CONCENTRATIONS IN SOIL

ENGINEERING-SCIENCE, INC.

FIGURE 4.2

Evaluation of Soil Remedial Alternatives

Site 1: POL Area

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a, e)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	◕	◔	◔	○	◕	◕	◔	◔	562,000
	S3: Soil Flushing (In-Situ) (d)	◕	◑	◔	○	◑	◔	○	○	1,007,000
	S4: Bio-remediation (In-Situ) (d)	◕	◑	◔	◔	◑	◔	◔	◑	867,000
	S10: Bioventing (In-Situ) (d)	◕	◑	◔	◔	◑	◔	◔	◑	267,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Groundwater Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) Contamination is not Mobile and is Isolated from Environmental Biota

For the POL Area, special consideration must be given when making final alternative selection to best combine soil remedial alternatives and groundwater remedial alternatives (see Section 5.1). The soil and groundwater alternatives can work together to provide an overall site solution for the POL Area.

4.1.1 S1: No Action (POL Area)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities, but soil contaminated with TPH at concentrations greater than 100 mg/kg generally will require long-term groundwater monitoring to track the potential spread of contamination. Groundwater monitoring will be addressed in Section 5.1. Land use restrictions may not be necessary, because there is very low expected risk to human health or the environment for present or anticipated future land use at the POL Area (Engineering-Science 1993). Under the no action scenario the adjacent drainage ditch may continue to be impacted by elevated TPH during periods when the water table is high.

Protection of human health and the environment: The no action alternative is currently protective of human health and the environment, because anticipated future and present land use options show very low quantifiable carcinogenic, noncarcinogenic, or environmental risk associated with the pathways evaluated for the POL Area (Engineering-Science 1993). Carcinogenic risks are 4×10^{-8} for base employees, 6×10^{-8} for residents and 2×10^{-9} for construction workers. All estimated risks are below the carcinogenic risk range of 1×10^{-6} as specified in the NCP.

Some potential risk remains, however, due to possible migration of existing contaminants from the soils to the groundwater. Protectiveness of the no action alternative will be addressed however, in the groundwater remedial alternatives evaluation (Section 5.1). The evaluation of groundwater remediation alternatives will address the contamination once it is transferred to groundwater.

Compliance with ARARs: A remedial action cleanup goal for TPH (100 mg/kg) has been established to provide protection of the underlying groundwater. The 100 mg/kg TPH level was established based on the LUFT guidance methodology (see Section 2). No other detected analytes exceeded PRGs or cleanup levels, therefore only TPH contamination requires remedial action. All estimated risks are below the carcinogenic risk range specified in the NCP.

The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Due to natural dispersion and attenuation the TPH contamination may eventually meet the remedial action objective if site conditions are favorable. However, the time required for this natural attenuation process cannot be accurately predicted, and the remedial action objective may not be achievable in an acceptable time period.

Location specific ARARs (critical habitat/or and endangered or threatened species) are satisfied because there is no expected risk to environmental receptors, and the

implementation of the no action alternative will not affect listed species or critical habitat.

Long-term effectiveness and permanence: Natural processes including biological activity, dispersion and attenuation would eventually reduce the TPH contamination to meet the remedial action objective if site conditions are favorable. However, this natural attenuation processes could require an excessive length of time to achieve the remedial action objective. Attenuation time can be estimated but additional investigation data on magnitude and extent of contamination are needed. Additionally, residual TPH contamination could impact the underlying groundwater. The groundwater remedial alternatives evaluation in Section 5.1 includes an assessment of remedial alternatives with consideration of long-term groundwater protection and monitoring.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would do almost nothing to reduce the toxicity, mobility, or volume of contaminants. Until contaminants are consumed or break down into less toxic compounds by natural processes, the mitigation of contaminants to the groundwater remains a possibility. Eventually the mobility and volume would decrease as a result of natural attenuation.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no significant impacts to the community, site workers, and environment resulting from this alternative. It is reasonable to assume that the plume will continue to migrate. Under the no action alternative, no additional exposure pathways would be created, and there would be very little risk to personnel conducting groundwater monitoring.

Implementability: This alternative is readily implemented because no remedial actions are required. However, administrative implementation may be difficult based on state and community acceptance.

Cost: The estimated cost for this alternative is presented in Table DW-1.1 in Appendix D. Capital, annual, or present worth costs associated with groundwater monitoring are presented in Table DW-1.1 in Appendix D. Capital cost is estimated to be $25,400. Present worth cost is estimated to be $562,000. These costs also apply to the no action groundwater alternative.

State acceptance: The no action alternative may be acceptable because groundwater remedial alternatives under evaluation in Section 4.2.1 will address the long-term risk. Regulatory acceptance may be difficult to attain because this alternative will not address the non-degradational policy of the SFRWQCB.

Community acceptance: Community acceptance may be difficult to attain due to public perceptions regarding land use and lack of active treatment of contaminants.

4.1.2 S3: In-Situ Soil Flushing (POL Area)

In-situ soil flushing has been reported as an effective remedial action for the removal of organics and inorganics from soils. Soil flushing is a process in which a flushing solution is sprayed, flooded, or injected over and into the soil area to be treated. As the

solution percolates through the treatment zone, it flushes/mobilizes contaminants from the soil matrix. The flushing solution carries the soil contaminants through the soil profile until it mixes with underlying groundwater. The solution is then collected in downgradient recovery wells or trenches and pumped to the surface for treatment. Appendix E presents a flow diagram of the process.

To implement the soil flushing alternative at the POL site, an extensive infiltration system and collection system would be required to improve remediation time and performance due to low-permeability soils on site. Additionally, groundwater monitoring would be necessary to ascertain that contaminants do not migrate beyond the remedial area boundaries during the remediation phase.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of four infiltration wells above the area of contamination (infiltration wells process option is selected over spray system);
- Construction of ten recovery wells downgradient of the area of contamination;
- Construction of the soil washing effluent treatment plant (granular activated carbon treatment);
- Treatment of soils with flushing solution;
- Discharge of treated groundwater;
- Soil sampling to monitor progress; and
- Groundwater sampling to confirm that contaminants are not migrating beyond the remedial area boundaries.

Protection of human health and the environment: The long-term potential risk associated with soil contamination at the POL site may be reduced because some of the contamination source would be removed if the flushing solution can be delivered to all soil in the contaminated area. Protection of human health and the environment needs to be considered because soil flushing would move the contaminants to the groundwater.

Compliance with ARARs: A remedial action objective for TPH (100 mg/kg) has been established, based on the LUFT guidance (see Section 2), to provide protection for the underlying groundwater. No other contaminants require remediation. Because of the rock subsurface and large areas of tight soil formation at the site, uniform site remediation to 100 mg/kg TPH may be difficult to achieve. A treatability study is recommended to evaluate the effectiveness of soil flushing at POL.

Because in-situ soil flushing involves groundwater treatment and discharge, action specific ARARs would apply. The treatment ARARs are dependent on the beneficial groundwater use, which has not been determined for this site. Discharge must meet the federal and local requirements prior to the discharge (see Section 3.3.6 for more detailed discussion about discharging treated water).

Action-specific ARARs include State Water Resources Control Board resolution number 68-16 "non-degradational policy" for groundwater and pretreatment standards for discharge to the POTW. The "non-degradational policy" may be difficult to satisfy because contaminants will be flushed to the groundwater and the groundwater extraction system may not be effective in recovering the contaminants due to the low hydraulic conductivities of the soils at the site.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction.

Long-term effectiveness and permanence: In-situ soil flushing is effective at removing TPH from the soil, thus removing some of the potential groundwater contamination source. It would be difficult to achieve the 100 mg/kg TPH cleanup goal in rock formations, and a treatability test may be necessary.

Reduction of toxicity, mobility, or volume through treatment: In-situ soil flushing would reduce the volume of the contaminants in the soil. However, the contaminants will become more mobile when transferred from the soil media to the groundwater. If the extraction system is not consistently effective, then the possibility of off-site migration of the contamination is increased.

Short-term effectiveness: Site workers installing infiltration wells, extraction wells, and the treatment system may be exposed to contaminated soil and groundwater. Impacts resulting from the exposure are expected to be minimal, with proper engineering controls and personal protection equipment. Flushing will accelerate migration to groundwater and cleanup time compared to the no action natural attenuation. However, by flushing contaminants to the groundwater, short-term effectiveness will depend on the effectiveness of the groundwater extraction and treatment system. Due to site conditions, specifically low hydraulic conductivities, effective extraction of the elutriate would be difficult.

Implementability: Components of soil flushing are commercially available, and it can be reliably operated when conditions are favorable. However, due to the low-permeability soils and unsaturated rock in the POL Area, implementation of this alternative will be difficult. To successfully extract the flushing solution effluent from media at low hydraulic conductivity, an extensive extraction system would be required. Under these site conditions, this alternative will be difficult to implement.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-1.2 in Appendix D. Capital costs are estimated to be $269,000 and annual costs are estimated to be $425,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-1. The present worth cost is estimated to be $1,007,000, assuming a 2-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance is anticipated to be difficult to achieve, because the transfer of soil contaminants to groundwater may not be acceptable especially since extraction of the soil flushing effluent would be difficult to implement.

Community acceptance: Community acceptance may be difficult to achieve due to implementation problems in extracting the soil washing effluent.

4.1.3 S4: In-Situ Bioremediation (POL Area)

In-situ bioremediation is a biological treatment process using naturally occurring or enhanced soil bacteria to consume hydrocarbons. To facilitate biological treatment, oxygen and nutrients are added to the soil. Because soils at the POL Area have a low permeability, an extensive infiltration system would be required to supply the micro-organisms with oxygen and nutrients. Under favorable conditions, bacteria populations would grow until the hydrocarbon foodstock is reduced. By-products of the treatment process will include fatty acids, carbon dioxide, water and other biologically accepted intermediate organic molecules.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of four infiltration wells upgradient and above the zone of contamination;
- Application of oxygen and nutrients;
- Soil sampling to monitor progress; and
- Groundwater monitoring to confirm that contaminants are not migrating off site.

Protection of human health and the environment: The potential risk resulting from migration of the existing soil contaminants to groundwater may be reduced because some of the contamination sources would degrade in an accelerated rate if the technology can be implemented and controlled.

Compliance with ARARs: There are no chemical specific ARARs for the detected analytes. However, a remedial action objective for TPH (100 mg/kg) has been established at the POL Area to provide protection of the underlying groundwater. No other contaminants require remediation. In-situ bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. However, because of the rocky and other tight soil formation in the subsurface, uniform site remediation to 100 mg/kg TPH may be difficult to achieve. A treatability study may be required.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: In-situ bioremediation would degrade most of the TPH in the soil, thus removing the potential groundwater contamination source. However, long-term effectiveness depends on the effectiveness of the infiltration system. Due to low soil permeability, the nutrient infiltration system may be difficult to control, and the long-term effectiveness of this alternative is needs to be addressed through a treatability study if this alternative is selected.

Reduction of toxicity, mobility, or volume through treatment: In-situ bioremediation would reduce the contaminant toxicity and volume. An infiltration system could potentially mobilize contaminants which may be difficult to contain due to the low hydraulic conductivity of the groundwater. Furthermore, because of the tight soil formations, not all the contaminants would be remediated.

Short-term effectiveness: Site workers installing infiltration wells may be exposed to low concentrations of contaminants. However, with engineering controls and personal protection equipment the alternative is protective of site workers and community during remediation. Overall cleanup time will be improved over natural attenuation. Effectiveness in meeting remedial objective depends on how effective nutrients and oxygen into the soils. This can be determined by a treatability test.

Implementability: In-situ bioremediation is a proven technology, components are commercially available, and it can be reliably operated when conditions are favorable. However, due to the low-permeability soils and unsaturated rock in the POL Area, implementation of this alternative will be difficult. Even with an extensive infiltration system to deliver oxygen and nutrients the technologies effectiveness in remediating all of the TPH contamination below the remedial action objective may not be possible.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-1.3 in Appendix D. Capital costs are estimated to be $285,000 and annual costs are estimated to be $234,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-1. The present worth cost is estimated to be $867,000, assuming a 3-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance may be difficult to achieve, because of the low soil permeabilities and the resulting difficulties in implementing the technology.

Community acceptance: Community acceptance should be attainable because public perception regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.1.4 S10: In-situ Bioventing (POL Area)

Deep subsurface contamination (below 10 feet) was detected in two general areas at the POL area: one near the top of the hill near monitoring well PL-MW-104 and the second area at the base of the hill near monitoring wells PL-M2-101, MW-114, and MW-115. During site investigation, positive Photo Ionization Detector (PID) readings were noted at between 12 feet to groundwater (28 feet) at MW-101. The PID near MW-104 did not detect hydrocarbons, however, the soil sample at 17 ft bgs had 503 mg/kg TPH. The soil in the zone of contamination is predominantly sandstone. The hydraulic conductivity was measured at 1.2×10^{-7} ft/sec. It may be possible to implement in-situ bioventing in both areas of contamination. A treatability test would be needed to evaluate potential performance in the field. Appendix E shows a process flow diagram of an in-situ bioventing system.

The sequence of activities that would be performed in this alternative consists of the following:

- Construction of venting wells;
- Insertion of piezo monitoring points;
- Install blower system; and
- Soil sampling to monitor progress.

Protection of human health and the environment: The potential risk resulting from migration of the existing soil contaminants to groundwater is minimized because most of the contamination source would degrade. Furthermore, the low risk to the environment identified in the risk assessment would be further reduced.

Compliance with ARARs: The concentrations of detected analytes are less than PRGs for those compounds for which PRGs can be established. A remedial action objective for TPH (100 mg/kg) has been established to provide protection of the underlying groundwater. In-situ bioventing has been proven to be an effective treatment for the remediation of TPH contamination in soil. The total risk for hypothetical future residents at the site is 6×10^{-8}. The only detected analyte that requires remediation is TPH which exceeds the SFRWQCB remedial action objective. Because of the tight soil formation in the fractured rock media, uniform site remediation to 100 mg/kg may be difficult to achieve. A treatability study is recommended to evaluate the effectiveness of in-situ bioventing at POL.

This alternative can be made consistent with location-specific ARARs with careful construction management and discharge management. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

With proper technology implementation, action specific ARARs associated with in-situ bioventing would be met including State of California requirements related to well installation.

Long-term effectiveness and permanence: In-situ bioventing would be effective in the long-term for TPH because most of the TPH would degrade in the soil, thus removing the potential groundwater contamination source. It would be difficult to achieve 100 mg/kg TPH in rock formations. A treatability study is needed to confirm this technology's effectiveness and establish design parameters at this site.

Reduction of toxicity, mobility, or volume through treatment: In-situ bioventing would reduce the toxicity and volume of TPH.

Short-term effectiveness: Site workers installing vent wells may be exposed to low levels of contamination. However, worker exposure can be minimized with engineering controls and personal protection equipment.

Implementability: In-situ bioventing may be readily implemented and components are commercially available. However, the low permeability soils at the site may impact the reliability of the system. An extensive vent system may be necessary to draw air

through the zone of contamination. A treatability study would have to be performed to determine the process's ability to induce flow.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-1.4 in Appendix D. Capital costs are estimated to be $108,000 and annual costs are estimated to be $64,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-1. The present worth cost is estimated to be $267,000, assuming a 3-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance may be difficult to achieve, because of the low soil permeabilities and the resulting difficulties in implementing the technology.

Community acceptance: Community acceptance should be attainable because public perception regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.2 SITE 2: BURN PIT

The Burn Pit has two distinct areas of soil contamination, soil directly beneath the pad and around the perimeter of the pad. Because of the differences in the physical setting between the two areas, remedial action alternatives will be evaluated separately for each area.

4.2.1 Beneath Pad

The Burn Pit pad is made of concrete, 2 feet thick and 125 feet in diameter. Results of the EI indicated that fuel hydrocarbon contamination is primarily in the upper 6 to 8 feet beneath the concrete pad (Engineering-Science 1993). One boring at the center of the pad detected TPH at 1,920 mg/kg immediately below the pad (2 ft depth) with concentrations decreasing uniformly to 17.3 mg/kg at 7 feet. Additionally, immediately below the pad (2 feet depth) the total benzene, toluene, ethyl benzene, and xylene (BTEX) was 3.0 mg/kg, total VOCs were 405 mg/kg, and total SVOCs were 148 mg/kg. The only analyte that exceeded ARARs, PRGs, or other cleanup goals was TPH. No additional chemicals of concern were identified in the human health risk assessment or the ecological risk assessment.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

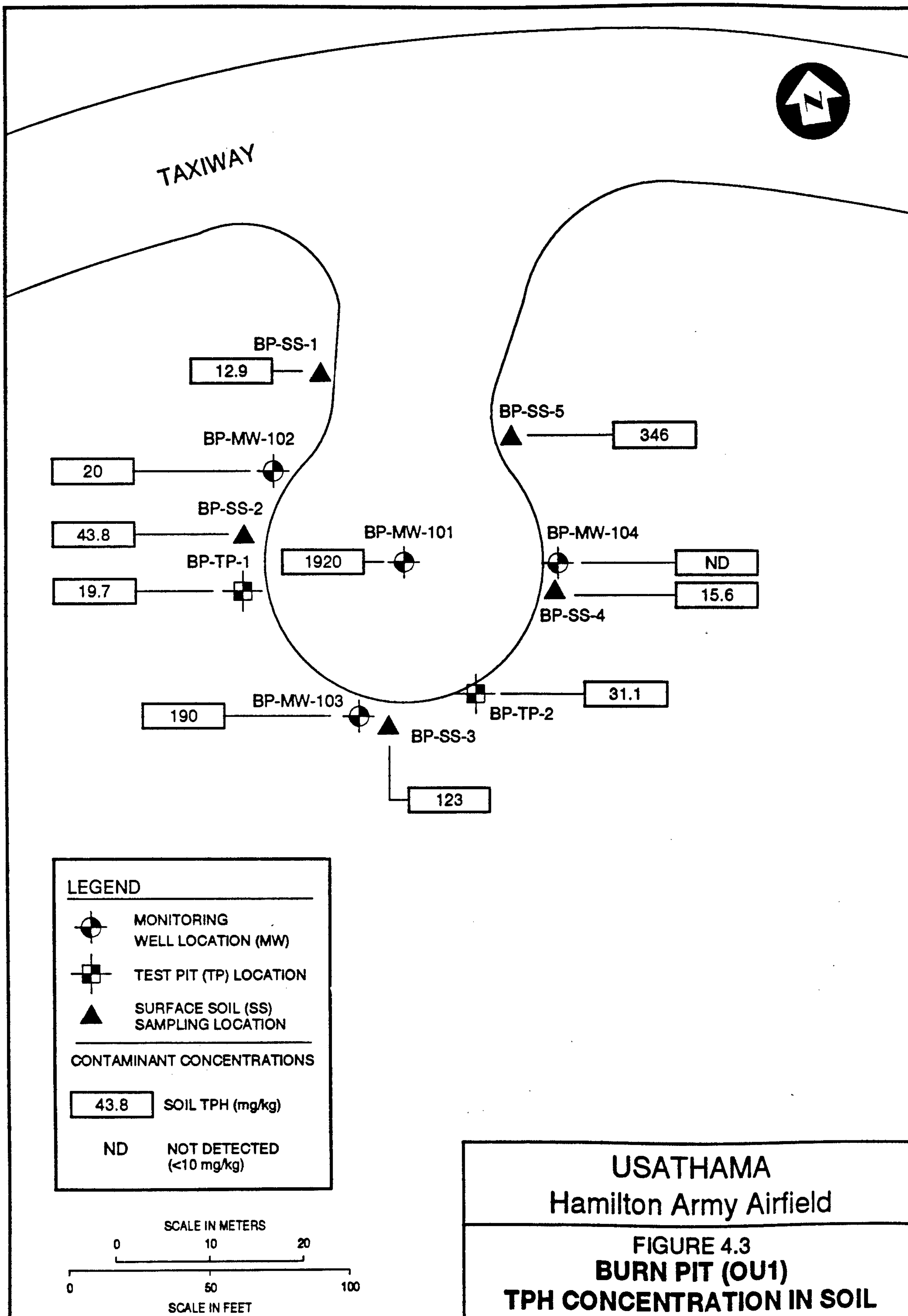
- S1: No Action;
- S4: In-Situ Bioremediation;
- S5: In-Situ Soil Vapor Extraction;
- S10: In-situ Bioventing; and
- S6: Excavation and Biological Treatment.

The estimated volume of TPH-contaminated soil with concentrations greater than 10 mg/kg is 3,350 cubic yards. Figure 4.3 shows the locations and maximum TPH concentration (per sample) at the Burn Pit Site.

The following five subsections present the evaluation of each alternative relative to the nine evaluation criteria. Additionally, Figure 4.4 presents the summary of the detailed analysis of the remedial alternatives retained relative to the evaluation criteria.

4.2.1.1 S1: No Action (Burn Pit - Beneath Pad). The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. Land use restrictions may not be necessary, because expected risks to human health and the environment are low, due to low contaminant concentration, toxicities, limited access, and natural degradation (Engineering-Science 1993). Soil contaminated with TPH at concentrations greater than 10 mg/kg generally will require long-term groundwater monitoring.

Protection of human health and the environment: The no action alternative is currently protective of human health and environment because anticipated future and



USATHAMA
Hamilton Army Airfield

FIGURE 4.3
BURN PIT (OU1)
TPH CONCENTRATION IN SOIL

REV. 3 C335-24.DWG 04/26/94

ENGINEERING-SCIENCE, INC.

FIGURE 4.4

Evaluation of Soil Remedial Alternatives

Site 2: Burn Pit-Beneath Pad

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a, e)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	◕	◑	◑	○	◕	◕	◔	◔	505,000
	S4: Bioremediation (In-Situ)(d)	◕	◑	◑	◑	◑	◔	◑	◕	245,000
	S5: Soil Vapor Extraction (In-Situ) (d)	◕	◑	◕	◑	◑	◑	◑	◕	223,000
	S10: Bioventing (In-Situ) (d)	◕	◑	◕	◑	◑	◑	◕	◕	141,000
	S6: Excavation & Biological Treatment (d)	◕	◕	◕	◕	◕	◑	●	●	206,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) Assumes Pad Provides Protection from Exposure to Biota and Reduces Infiltration

present land use options show very low quantifiable carcinogenic, non-carcinogenic or environmental risk associated with the pathways evaluated for the Burn Pit. Carcinogenic risks are $1x10^{-7}$ for base employees, $1x10^{-7}$ for residents, and $1x10^{-9}$ for construction workers. All estimated risks are below the carcinogenic risk range of $1x10^{-6}$ as specified in the NCP (Engineering-Science 1993). However, some potential risk remains, resulting from migration of existing soil contaminants to the groundwater. The contamination may naturally degrade over a very long time.

Compliance with ARARs: A remedial cleanup goal for TPH (10 mg/kg) has been established to provide protection to the underlying groundwater. No other detected analytes exceed PRGs or cleanup levels. All estimates are below the carcinogenic risk range specified in the NCP.

The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Due to natural dispersion and attenuation the TPH contamination may eventually meet the remedial action objective if site conditions are favorable. However, the time required for this natural attenuation process is long and cannot be accurately predicted without additional contamination data.

Location specific ARARs appear to be satisfied because the burrowing owl (a listed endangered species), would not be able to burrow under the pad, and thus could not come in contact with the contamination.

Long-term effectiveness and permanence: The no action alternative would not be directly effective in removing residual contamination that could impact the underlying groundwater. Natural dispersion and attenuation of the contamination may eventually meet the remedial action objective if site conditions are favorable. However, the time required for this natural attenuation process cannot be accurately predicted, and the soil cleanup goal for TPH may never be achieved if the pad remains in place. Nevertheless, residual contamination in the soil was determined to not pose a significant public health risk or risk to the environment for this site (Engineering-Science 1993), although groundwater quality can potentially be impacted if the soil contamination is not remediated.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would do almost nothing to directly reduce the toxicity, mobility, or volume of contaminants. Contaminant migration continues until natural attenuation eventually reduces the toxicity and volume of contamination.

Short-term effectiveness: Short-term effectiveness is partially achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative. However, the time for natural attenuation is very long and potential migration of contaminants from soil to groundwater remain.

Implementability: Technically this alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to state and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-2.1.1 in Appendix D. As indicated, costs associated with groundwater monitoring are expected even though no remedial actions are to be implemented. Capital costs of $17,000 are associated with installation of wells. Annual costs of approximately $52,000 are associated with monitoring and present worth costs of $505,000 are estimated assuming 30 years of operation and a 10 percent annual interest rate. The costs also apply to the no action alternative at the perimeter of the Burn Pit pad. A variation of the no action alternative assumes no groundwater monitoring. The cost for this alternative is $1,000 and is explained in Section 5.

State acceptance: Regulatory acceptance may be difficult to attain because this alternative will not achieve the TPH cleanup level of 10 mg/kg through treatment. Regulatory acceptance may be attainable because the contamination may naturally degrade over time, however, the time cannot be accurately predicted.

Community acceptance: Community acceptance may also be difficult to attain due to public perceptions regarding land use and lack of active treatment of contaminants.

4.2.1.2 S4: In-Situ Bioremediation (Burn Pit - Beneath Pad). In-situ bioremediation is a treatment process using naturally occurring or enhanced soil bacteria to consume hydrocarbons. To enhance biological treatment, oxygen and nutrients are added to the soil. Because the contaminated soil is below the concrete pad, an extensive infiltration system would be required to supply the micro-organisms with oxygen and nutrients. Under favorable conditions, bacteria populations would grow until the hydrocarbon foodstock is reduced. By-products of the treatment process will include fatty acids, carbon dioxide, water and other biologically accepted intermediate organic molecules. Appendix E shows a process flow diagram.

Most of the contamination is less than 6 feet below the pad surface. Except for the center of the pad, most of the pad is thought to be on a sandy-gravelly backfill material that is up to 3 feet thick along the perimeter of the pad. Four biovent wells would be installed off center from the pad slotted in the bay mud zone down to 6 feet deep.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of four infiltration wells and extraction wells;
- Application of oxygen and nutrients; and
- Soil sampling to monitor progress.

Protection of human health and the environment: The potential risk resulting from migration of the existing soil contaminants to groundwater is minimized because most of the contamination source would degrade. Furthermore, the current low risk to human health and the environment identified in the risk assessment would be further reduced.

Compliance with ARARs: The concentrations of detected analytes are less than PRGs for those compounds for which PRGs can be established. A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. In-

situ bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the cleanup goal may be attained, however it may be difficult to attain ARARs uniformly under the pad because of the tight soil formations. A treatability study is recommended.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location specific ARARs appear to be satisfied because the burrowing owl (a listed endangered species) would not be able to burrow under the pad, and thus could not come in contact with the contamination.

With proper technology implementation, action specific ARARs associated with in-situ bioremediation would be met.

Long-term effectiveness and permanence: In-situ bioremediation would be effective in the long-term for TPH because most of the TPH would degrade in the soil, thus removing the potential groundwater contamination source. Consequently, the very low human health and environmental risk would be further reduced. The alternative would be effective in achieving the 10 mg/kg TPH cleanup goal if the contamination is primarily in the more permeable fill material direct beneath the pad instead of the underlying bay mud.

Reduction of toxicity, mobility, or volume through treatment: In-situ bioremediation would reduce the toxicity and volume associated with TPH.

Short-term effectiveness: Site workers installing infiltration wells could be exposed to a low levels of contamination, however, exposure can be minimized with engineering controls and personal protection equipment.

Implementability: In-situ bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. However, the bioremediation process may be difficult to control, because of low permeable soils at the site. An extensive infiltration system would be necessary to deliver oxygen and nutrients.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.1.2 in Appendix D. Capital costs are estimated to be $74,000 and annual costs are estimated to be $69,000 per year for 3 years. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $245,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable if the treatability test results are favorable.

Community acceptance: Community acceptance should be attainable because public perception regarding active treatment of soil contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.2.1.3 S5: In-situ Soil Vapor Extraction (Burn Pit - Beneath Pad). Soil vapor extraction has been used successfully to remediate sites contaminated with VOCs. Air is drawn through the zone of contamination mobilizing contaminants which are captured by

the activated carbon at the discharge from the vacuum blower. In general, constituents with vapor pressures above 0.1 mm Hg at native soil temperatures (60°F) would be affected.

Thermally enhanced soil vapor extraction is a variation of soil vapor extraction. It increases the rate of contaminant volatilization by raising soil temperatures. The volatilized organic vapors are then drawn from the soil at the surface into an off-gas treatment system. Two methods for heating the soil include radio/microwave heating and steam injection.

Radio/microwave heating involves the use of radio frequency or microwave plasma energy to desorb organic contaminants from in-situ soils. The soil material converts the energy to heat as a result of dipole rotation and molecular vibration. This results in mobilization of contaminants by vaporization or thermal decomposition. Operating temperatures range from 200° to 750° F. The mobilized contaminants are then collected at the surface in a hood and drawn into an off-gas treatment system.

Steam injection is another typical thermal process. It consists of forcing steam through contaminated soil, via injection wells, to thermally enhance the soil vapor extraction process. The vapor extraction is completed by applying a vacuum to a well or trench and inducing a flow of air through contaminated soils. The steam injection and vapor extraction working together air-strip the organic contaminants in the soil matrix. The recovered gaseous contaminants are then either condensed and processed/recycled or absorbed by activated carbon filters. The technology uses readily available components such as extraction and monitoring wells, a vapor liquid separator, a vacuum pump, and emission control equipment.

Appendix E presents a process flow diagram. Thermal soil vapor extraction is not considered in this alternative analysis. The sequence of activities that would be performed include:

- Construction of 4 vapor extraction wells;
- Implement treatment system (vacuum blower, separator, and carbon units);
- Treat soils;
- Sample subsurface soil to confirm remediation goals; and
- Off-site recycle/disposal of the spent carbon.

Protection of human health and the environment: The potential risk resulting from migration of the existing soil contaminants to groundwater is minimized because ideally most of the mobile contamination source would be removed by the extraction process. Furthermore, the already low risk to the environment would be further reduced.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Soil vapor extraction has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the cleanup goal may be attained. However, if heavy hydrocarbons or oils are present, this treatment may not be able to remove all the

contamination. A treatability study is recommended. No other detected analytes exceeded PRGs or cleanup goals.

Action specific ARARs that apply to soil vapor extraction include air quality regulations in controlling potential vapor emissions. These emissions would be adequately controlled with activated carbon and appropriate monitoring.

This alternative can be made consistent with location-specific ARARs with careful discharge management and construction management. Location-specific ARARs appear to be satisfied because the burrowing owl (a listed endangered species) would not be able to burrow under the pad, and thus could not come in contact with the contamination.

With proper technology implementation, all action specific ARARs associated with this technology would be met. Action specific ARARs include air discharge requirements, and management (Department of Transportation requirements and recycling/disposal facility requirements) of spent carbon.

Long-term effectiveness and permanence: Soil vapor extraction would be effective for TPH in the long-term because most of the TPHs would be removed from the soil. Consequently, the currently very low human health and environmental risks would be further reduced. However, if heavy hydrocarbons or oils are present, this treatment may not be able to remove all the contamination. The alternative would be effective in achieving the 10 mg/kg TPH cleanup goal if the contamination is primarily in the more permeable fill material direct beneath the pad instead of the underlying bay mud.

Reduction of toxicity, mobility, or volume: Soil vapor extraction would reduce the volume of volatile contaminants, but not the toxicity or mobility of the contamination.

Short-term effectiveness: Site workers installing extraction wells may be exposed to low levels of contamination. However, exposure can be minimized with engineering controls and personal protection equipment.

Implementability: Soil vapor extraction may be readily implemented and components are commercially available. However, the low permeability of soils at the site may impact reliability of the system. An extensive extraction system may be necessary to extract the gaseous contaminants. A treatability study would have to be performed to determine the process's ability to induce flow through the contaminated soils.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.1.3 in Appendix D. Capital costs are estimated to be $75,000 and annual costs are estimated to be $85,000 per year for 2 years. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $223,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable if the treatability study results indicate that the process is implementable.

Community acceptance: Community acceptance should be attainable because public perception regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.2.1.4 S13: In-situ Bioventing (Burn Pit - Beneath Pad). The microorganisms naturally occurring in the soil are stimulated by drawing or pumping air through the zone of contamination below the pad. Most of the contamination is less than 6 feet below the pad surface. Except for the center of the pad, most of the pad is reported to be on a sandy-gravelly backfill material that is up to 3 feet thick along the perimeter of the pad. Four biovent wells would be installed off center from the pad slotted in the bay mud zone down to 6 feet deep. Air would preferentially flow through the more permeable back fill and into the bay mud. The bay mud is a relatively tight formation and the zone of influence would be limited. The area of influence and effectiveness of bioventing would require a pilot test prior to full scale implementation. Only low volumes of air would be withdrawn and no emissions treatment would be needed. Soil sampling, possibly by horizontal boring, could be used to verify that the remediation is complete. Appendix E shows a process flow diagram of an in-situ biovent system.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of wells;
- Insertion of vacuum or pressure monitoring points;
- Install blower system; and
- Soil sampling to monitor progress.

Protection of human health and the environment: The potential risk resulting from migration of the existing soil contaminants to groundwater is minimized because most of the contamination source would degrade. Furthermore, the low risk to the environment identified in the risk assessment would be further reduced.

Compliance with ARARs: The concentrations of detected analytes are less than PRGs for those compounds for which PRGs can be established. A remedial action objective for TPH (10 mg/kg) has been established to provide protection for the underlying groundwater. In-situ bioventing has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. A pilot test is recommended.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs appear to be satisfied because the burrowing owl (a listed endangered species) would not be able to burrow under the pad, and thus could not come in contact with the contamination.

With proper technology implementation, action specific ARARs associated with in-situ bioventing would be met including State of California requirements related to well installation.

Long-term effectiveness and permanence: In-situ bioventing would be effective in the long-term for TPH because most of the TPH would degrade in the soil, thus removing the potential groundwater contamination source. The alternative would be effective in achieving the 10 mg/kg TPH cleanup goal if the contamination is primarily in the more permeable fill material direct beneath the pad instead of the underlying bay mud. A treatability study is recommended. Consequently, the low human health and environmental risks would be further reduced.

Reduction of toxicity, mobility, or volume through treatment: In-situ bioventing would reduce the TPH toxicity, mobility, and volume.

Short-term effectiveness: Site workers installing vent wells may be exposed to low levels of contamination. However, exposure can be minimized with engineering controls and personal protection equipment.

Implementability: In-situ bioventing may be readily implemented and components are commercially available. However, the biovent process may be difficult to control because of low permeable soils at the site. In addition, moisture levels of over 40 percent have been detected and excess moisture would impede the effectiveness of bioventing. An extensive system may be necessary to draw air through the zone of contamination. A pilot test would have to be performed to determine the process's ability to induce flow in Bay Mud soil.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.1.4 in Appendix D. Capital costs are estimated to be $42,000 and annual costs are estimated to be $40,000 per year for 3 years. It is assumed that groundwater monitoring would continue for one additional year after treatment is complete to verify that the groundwater has not been impacted. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $141,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable if the pilot test results indicate that the process can be effective.

Community acceptance: Community acceptance should be attainable because public perception regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.2.1.5 S6: Excavation and Biological Treatment (Burn Pit - Beneath Pad). Biological treatment of contaminated soil has been proven effective for degrading TPH, VOCs, and SVOCs. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit. The soil is aerated either mechanically by mixing or tilling the soil, or passively through a vent pipe placed in the soil pile. Since the flow rate is very low, emissions control would not be necessary. Typically the remediation period is 6 to 18 months. A process flow diagram is presented in Appendix E.

The sequence of activities that would be performed upon implementation of this alternative consist of the following:

- Construction of the treatment unit (possibly including vent pipe and blower);
- Removing the 2-ft thick 125-ft diameter concrete pad;
- Excavation of contaminated soils and placement in treatment unit;
- Application of nutrients and micro-organisms if needed;
- Tilling of soils or drawing air through soil piles;
- Biodegradation of contaminated soils;
- Soil sampling to monitor contaminant degradation progress;
- Backfilling and compaction of the excavation; and
- Regrading the site.

Protection of human health and the environment: The already low risk to human health and the environment would be further reduced. The risk resulting from potential migration of contaminants to groundwater would be further reduced because most of the contamination source would be degraded.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Biodegradation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the cleanup goal may be attained.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction.

All action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction.

These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are treated with a specific treatment technology or until constituent concentrations are reduced below specific levels. Lead concentrations are of particular concern. Although lead does not exceed the 535 mg/kg cleanup goal, the area has elevated lead levels which potentially may not pass TTLC, STLC criteria for land disposal. It may be necessary to provide additional soil treatment prior to land disposal.

Long-term effectiveness and permanence: Biodegradation would be protective in the long-term because most of the TPH in the soil would be degraded.

Reduction of toxicity, mobility, or volume: Biodegradation would reduce the toxicity and volume of the TPH contamination, but not the mobility.

Short-term effectiveness: Site workers may be exposed to low levels of contamination during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Remedial objectives could be achieved in approximately two years.

Implementability: Biodegradation may be readily implemented as it is proven technology, components are commercially available, and it can be reliably operated. Over twelve thousand square feet of 2 foot thick concrete which could be contaminated would have to be removed and possibly treated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.1.5 in Appendix D. Capital costs are estimated to be $107,000 and annual costs are estimated to be $57,000 per year for 2 years. It is assumed that groundwater monitoring would continue for one additional year after treatment is complete to verify that the groundwater has not been impacted. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $206,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contamination in soil.

Community acceptance: Community acceptance should be attainable because public perception regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.2.2 Perimeter of the Pad

TPH was detected in the soil around the perimeter of the Burn Pit Pad at a maximum concentration of 346 mg/kg. Lead was detected at a maximum concentration of 55 mg/kg, which does not exceed the lead cleanup goal of 535 mg/kg. Only TPH exceeded PRGs, cleanup goals, or ARARs. No other analytes were identified in the human health risk assessment or ecological assessment that requires remediation (Engineering-Science 1993). Figure 1.4a shows the area of contamination at the Burn Pit. The estimated volume of TPH contaminated soil with concentrations above 10 mg/kg is 2,600 cubic yards.

Remedial alternatives retained for this site after evaluation in the initial screening (Section 3.2) include:

- S1: No Action;
- S6: Excavation and Biotreatment;
- S8: Excavation and Low Temperature Thermal Desorption; and
- S10: In-situ Bioventing.

The following four subsections present the evaluation for the alternatives relative to the nine evaluation criteria. Additionally, Figure 4.5 presents the summary of the detailed analysis of the remedial alternative retained relative to the evaluation criteria.

FIGURE 4.5

Evaluation of Soil Remedial Alternatives

Site 2: Burn Pit-Perimeter of Pad

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	Partial	Partial	Low	None	Moderate	Moderate	Low	Low	505,000
	S6: Excavation & Biological Treatment (d)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	165,000
	S8: Excavation & Thermal Desorption (d)	Moderate	Moderate	Moderate	Moderate	Partial	Moderate	Moderate	Partial	537,000
	S10: Bioventing (In-Situ) (d)	Partial	Partial	Moderate	Partial	Partial	Partial	Moderate	Moderate	141,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to
Determine the Effectiveness of Alternative

4.2.2.1 S1: No Action (Burn Pit Perimeter). The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. Land use restrictions may not be necessary, because there is a low expected risk to human health and a low risk to the environment (Engineering-Science 1993). Contaminated soil left in place with TPH concentrations greater than 10 mg/kg may require long-term groundwater monitoring.

Protection of human health and the environment: The no action alternative is currently protective of human health and the environment, because anticipated future and present land use options show very low quantifiable carcinogenic, noncarcinogenic, or environmental risk associated with the pathways evaluated for the Burn Pit (Engineering-Science 1993). Carcinogenic risks are 1×10^{-7} for base employees, 1×10^{-7} for residents and 4×10^{-9} for construction workers. All estimated risks are below the carcinogenic risk range specified in the NCP. The contamination may naturally degrade over time, however, the time cannot be accurately predicted. Surface soil contamination may be entrained in runoff and eventually discharge into the Bay, potentially increasing the human health risks.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Concentrations for chemicals of concern are below PRGs for those analytes that PRGs can be calculated. Lead levels are below 535 mg/kg which is the calculated acceptable inorganic lead level for HAA based on DTSC guidance.

The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Location specific ARARs are not satisfied because there is a low expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative is not directly effective in reducing residual contamination. Furthermore, residual contamination could migrate to the underlying groundwater. The contamination may naturally degrade over time, however, this cannot be accurately predicted with available data.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative does not directly reduce the toxicity, mobility, or volume of contaminants through treatment. Eventually most contaminants would diminish.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative. No additional migration pathways are created but the potential migration of contaminants to groundwater remains.

Implementability: Technically this alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-2.2.1 in Appendix D. As indicated, monitoring costs are expected because groundwater monitoring may be necessary. Capital costs of $17,000 are associated with monitoring during the first year. Annual costs of approximately $52,000 are associated with monitoring and present worth costs of $505,000 are estimated assuming 30 years of operation and a 10 percent annual interest rate. These costs also apply to the no action alternative for beneath the pad. A variation of the no action alternative assumes no groundwater monitoring. The cost for this alternative is $1,000 and is explained in Section 5.

State acceptance: Regulatory acceptance may be difficult because this alternative would not achieve the TPH cleanup goal of 10 mg/kg through treatment. Regulatory acceptance may be attainable because the contamination may naturally degrade over time, however, the time cannot be accurately predicted.

Community acceptance: Community acceptance may be difficult to obtain due to public perceptions, regarding land use and lack of active treatment of contaminants.

4.2.2.2 S6: Excavation and Biological Treatment (Burn Pit Perimeter). Biological treatment of contaminated soil has been proven effective for degrading TPHs. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled surface treatment unit. The soil is aerated either mechanically by tilling the soil or passively through a vent pipe placed in the soil pile. Since the flow rate is very low, emissions control would not be necessary. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade the contaminants in the soil. Nutrients or special microorganisms can also be added to enhance the remediation process.

The sequence of activities that would be performed upon implementation of this alternative consist of the following:

- Construction of the treatment unit (possibly including vent pipe and blower);
- Excavation of contaminated soils and placement in treatment unit;
- Application of nutrients and micro-organisms if needed;
- Tilling of soils or draw air through soil piles;
- Biodegradation of contaminated soils;
- Soil sampling to monitor contaminant degradation progress;
- Backfilling and compaction of the excavation; and
- Regrading the site.

Protection of human health and the environment: The already low risk to the environment, and the risk resulting from potential migration of contaminants to groundwater would be further reduced because most of the contamination source would be degraded.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. A pilot test is recommended to determine degradation rates.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

All the action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to a be RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are treated with a specific treatment technology or until constituent concentrations are reduced below specific levels. Lead concentrations are of particular concern. Although lead does not exceed the 535 mg/kg cleanup goal, the area has elevated lead levels which potentially may not pass TTLC, STLC criteria for land disposal. It may be necessary to provide additional soil treatment prior to land disposal.

Long-term effectiveness and permanence: Bioremediation would be protective in the long-term because most of the TPH in the soil would be degraded.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the toxicity and volume of the TPH contamination, but not the mobility.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Remedial objectives could be achieved in approximately two years.

Implementability: Bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.2.2 in Appendix D. Capital costs are estimated to be $72,000 and annual costs are estimated to be $54,000 per year for 2 years. It is assumed that groundwater monitoring would continue for one additional year after treatment is complete to verify that the groundwater has not been impacted. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $165,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contamination in soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.2.2.3 S8: Excavation and Low Temperature Thermal Desorption (Burn Pit Perimeter). Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments, and sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800° F) can be adjusted to remove TPHs, VOCs, or SVOCs.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense the organic compounds and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads;
- Excavation of contaminated soils and transport to storage pad;
- Screening all material larger than 2 inches from soil;
- Shredding material larger than 2 inches;
- Conveying soils to processing system;
- Transferring treated soil to storage pad for temporary storage;
- Sampling treated soil to monitor contaminant removal;
- Backfilling and compaction of the excavation;
- Regrading the site; and
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon.

Protection of human health and the environment: The current low risk to human health and the environment, and the risk resulting from migration of TPHs to groundwater would be further reduced because the most of the contamination source would be removed.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, on site soil replacement and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are treated with a specific technology or until constituents concentrations are reduced below specific levels. Lead concentrations are of particular concern. Although lead does not exceed the 535 mg/kg cleanup goal, the area has elevated lead levels which potentially may not pass TTLC, STLC criteria for land disposal. It may be necessary to provide additional soil treatment prior to land disposal.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the TPH would be removed from the soil.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the toxicity, mobility, and volume of the TPH contamination.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be safely implemented effectively. Air emissions must be monitored and controlled. Remedial objective could be achieved in approximately one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.2.3 in Appendix D. Capital and operating costs are estimated to be $537,000 and the project life is estimated to be four months. It is assumed that groundwater monitoring would continue for one additional year after treatment is complete (two years

total) to verify that the groundwater has not been impacted. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $537,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be difficult because of public perception regarding thermal treatment process.

4.2.2.4 In-situ Bioventing (Burn Pit Perimeter). A single vent well would be placed near BP-MW-103 where subsurface TPH contamination has been detected. The microorganisms in the soil are stimulated by drawing air through the zone of contamination. The bioventing system would be interconnected to the vent wells inside the burn pit pad if that alternative is selected. Since only low volumes of air are needed, it may be possible to remediate soils in the tight Bay Mud formation. The soil would be sampled to verify that the remediation is complete.

Appendix E shows a process flow diagram of an in-situ biovent system. The sequence of activities that would be performed include:

- Construction of 1 vent well;
- Construction of treatment system (vacuum blower, separator, and carbon units);
- Treatment of soils; and
- Sample subsurface soil to confirm remediation goals.

Protection of human health and the environment: The currently low risk to human health and the environment identified in the risk assessment would be further reduced. The potential risk resulting from migration of the existing soil contaminants to groundwater is minimized because most of the contamination source would degrade.

Compliance with ARARs: The concentrations of detected analytes are less than PRGs for those compounds for which PRGs can be established. However, a cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. A pilot test is needed to confirm that 10 mg/kg could be achieved in Bay Mud because of the very low hydraulic conductivity. In-situ bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained.

This alternative can be made consistent with location-specific ARARs with careful management of discharge during construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

With proper technology implementation, action specific ARARs associated with in-situ bioventing would be met including State of California requirements related to well installation.

Long-term effectiveness and permanence: In-situ bioventing would be effective in the long-term for TPH because most of the TPH would degrade in the soil, thus removing the potential groundwater contamination source. Consequently, the low environmental risk would be further reduced.

Reduction of toxicity, mobility, or volume through treatment: In-situ bioventing would reduce the TPH toxicity mobility and volume.

Short-term effectiveness: Site workers installing vent wells may be exposed to low levels of contamination. However, exposure can be minimized with engineering controls and personal protection equipment.

Implementability: In-situ bioventing may be readily implemented and components are commercially available. However, the biovent process may be difficult to control, because of low permeability soils at the site. In addition, moisture levels of over 40% have been detected at the site. Excessive moisture would impede the effectiveness of bioventing. An extensive vent system may be necessary to draw air through the zone of contamination. A pilot test would have to be performed to determine the process's ability to induce flow in Bay Mud soil.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-2.2.4 in Appendix D. Capital costs are estimated to be $42,000 and annual costs are estimated to be $40,000 per year for 3 years. It is assumed that groundwater monitoring would continue for one additional year after treatment is complete to verify that the groundwater has not been impacted. Monitoring costs are included in Table DWM-2. The present worth cost is estimated to be $141,000, assuming a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil. However, a cleanup goal of 10 mg/kg TPH should be based on the results of a treatability study.

Community Acceptance: Community acceptance should be attainable because of public perception regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.3 SITE 3: REVETMENT AREA

Shallow soil contamination was detected at a few sporadic locations around the periphery of several of the concrete Revetment Pads and the Engine Test Pad during Phase I of the EI. During Phase II of the EI, additional samples were collected at those pads where TPH concentrations for Phase I were above 100 mg/kg to further define the extent and magnitude of the contamination. The highest TPH concentration of 302 mg/kg was detected in one sample near Revetment Pad 26. The three other samples collected during Phase II near the same pad were all non-detect. Figure 4.6 shows the locations of TPH concentrations at the Revetment and Engine Test Pad site. The only analyte that exceeded ARARs, PRGs or cleanup goals was TPH. No other analytes were identified in the human health or ecological risk assessment that require remediation (Engineering-Science 1993). Tentatively identified VOCs are present in some soil samples which may affected the effectiveness of the selected alternative.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S6: Excavation and Biotreatment; and
- S8: Excavation and Low Temperature Thermal Desorption.

The estimated soil volume with TPH contamination greater than 10 mg/kg for the Revetment Area is approximately 66,000 cubic yards. The areas of contamination are shown in Figure 1.5 and also includes Pad 29 which is located near Building 26, 1,000 feet west of Pad 18 (not shown in Figure 1.5)

The following three sections present the evaluation for the three alternatives relative to the evaluation criteria. Additionally, Figure 4.7 presents the summary of the detailed analysis of each remedial alternative retained relative to the evaluation criteria. This figure assumes that TICs do not impact the alternative effectiveness. This should be verified in each case by a treatability study or better definition of the TICs.

4.3.1 S1: No Action (Revetment)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. Contaminated soil left in place with TPH concentrations greater than 10 mg/kg may require long-term groundwater monitoring. Land use restrictions may not be necessary, because there is no expected risk to human health or the environment for the present land use option in the Revetment Area (Engineering-Science 1993).

Protection of human health and the environment: The no action alternative is currently protective of human health and the environment, because anticipated future and present land use options show very low quantifiable carcinogenic, noncarcinogenic, or environmental risk associated with the pathways evaluated for the Revetment Site (Engineering-Science 1993). Carcinogenic risks are 9×10^{-9} for base employees, 1×10^{-8}

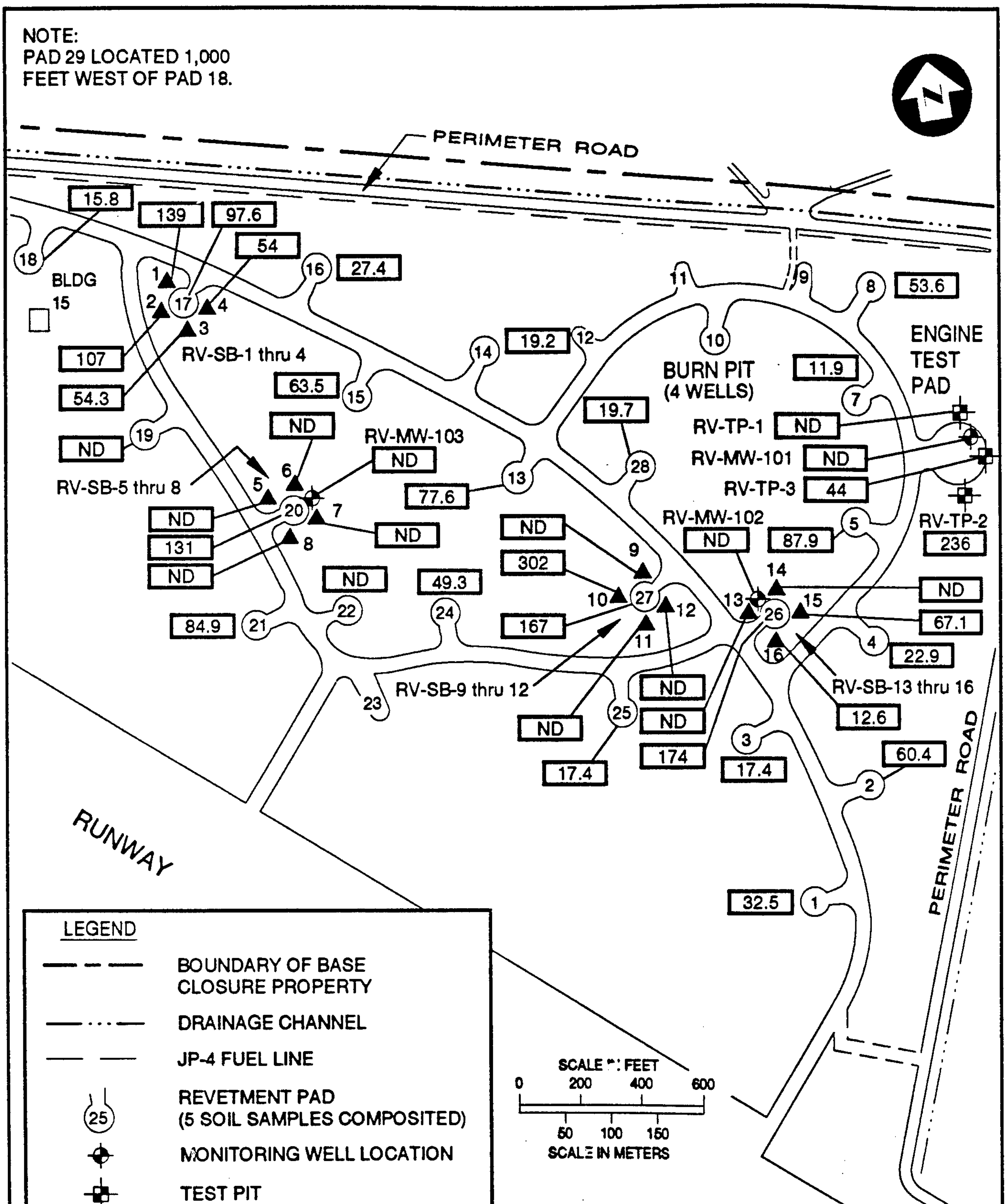


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FIGURE 4.6
REVETMENT AREA (OU1)
TPH CONCENTRATIONS IN SOIL

FIGURE 4.7

Evaluation of Soil Remedial Alternatives

Site 3: Revetment and Engine Test Pad Area

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	◒ Partial	◒ Partial	◒ Partial	○ No	◕ Moderate	◕ Moderate	◔ Low	◔ Low	496,000
	S6: Excavation & Biological Treatment (d)	◕ Moderate	◕ Moderate	◕ Moderate	◕ Moderate	◕ Moderate	◕ Moderate	● High	● High	2,252,000
	S8: Excavation & Thermal Desorption (d)	◕ Moderate	◕ Moderate	◕ Moderate	◕ Moderate	◒ Partial	◕ Moderate	◕ Moderate	◒ Partial	11,487,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◒ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◒ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

for residents and $1x10^{-9}$ for construction workers. All estimated risks are below the carcinogenic risk range specified in the NCP. The contamination will naturally degrade over a very long time.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. No other detected analytes exceed PRGs or cleanup levels and therefore only TPH contamination requires remedial action. The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Due to natural dispersion and attenuation the TPH contamination may eventually meet the remedial action objective if site conditions are favorable. However, the time required for this natural attenuation process cannot be accurately predicted, and the remedial action objective may not be achievable in an acceptable time period.

There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs (critical habitat and/or endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs are not satisfied because there is a low expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: Residual contamination was determined to not pose a human health risk and no environmental risk for the Revetment Area (Engineering-Science 1993). However, the no action alternative is not directly effective in reducing residual contamination. Furthermore, residual contamination could impact the underlying groundwater. The contamination may naturally degrade over time, however, this cannot be accurately predicted.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants through treatment. Most contaminants would diminish over a long time period.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative. No additional migration pathways are created but the potential migration of contaminants to groundwater remains.

Implementability: Technically, this alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-3.1 in Appendix D. As indicated, annual groundwater monitoring costs are expected. Capital costs of $16,000 are associated with monitoring he three existing wells. Annual costs of approximately $51,000 are associated with monitoring and present worth costs of $496,000 are estimated assuming 30 years of operation and a 10 percent annual interest rate. A variation of the no action alternative assumes no

groundwater monitoring. The cost for this alternative is $1,500 and is explained in Section 5.

If the regulatory agencies agree to reduce the number of years required for groundwater monitoring, the cost for the no action alternatives would be less. Agencies may consider eliminating the monitoring requirement if several successive monitoring events show no contamination is present.

State acceptance: Regulatory acceptance may be difficult because this alternative would not achieve the TPH cleanup goal of 10 mg/kg.

Community acceptance: Community acceptance may be difficult to obtain due to public perceptions, regarding land use and lack of active treatment of contaminants.

4.3.2 S6: Excavation and Biotreatment (Revetment)

Biological treatment of contaminated soil has been proven effective for degrading TPH. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled surface treatment unit. The soil is aerated either mechanically by tilling the soil or passively through a vent pipe placed in the soil pile. A blower draws the air through the pile and since the flow rate is low, emissions control would not be necessary. Aeration stimulates the metabolism and growth of indigenous microorganisms that can degrade contaminants in the soil. Nutrients or special microorganisms can also be added to enhance the remediation process.

Typically degradation is assumed to take 6 to 18 months. A process flow diagram is presented in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit (possibly including vent pipe and blower);
- Excavation of contaminated soils and placement in treatment unit;
- Application of nutrients and micro-organisms if needed;
- Tilling of soils or draw air through soil piles;
- Biodegradation of contaminated soils;
- Soil sampling to monitor contaminant degradation progress;
- Backfilling and compaction of the excavation; and
- Regrading the site.

Protection of human health and the environment: The low risk to the environment, and the risk resulting from migration of TPH contaminants to groundwater would be reduced because most of the TPH contamination source would degrade.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under

favorable conditions the remedial action objective may be attained. A pilot test is recommended to determine degradation rates.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

All the action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA, land disposal restrictions will apply. Lead concentrations range between 6.38 mg/kg to 51 mg/kg. The soil may pass TCLP requirements for land disposal without additional treatment. This must be verified through testing.

Long-term effectiveness and permanence: Bioremediation would be protective for TPH in the long-term because most of the TPHs would be degraded in the soil, thus removing the potential groundwater contamination source.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the TPH toxicity, mobility and volume.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Exposure of community is minimal during remedial action. Remedial objective could be achieved in the order of two years.

Implementability: Bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-3.2 in Appendix D. Capital costs are estimated to be $1,083,000, and annual costs are estimated to be $674,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-3. The present worth cost is estimated to be $2,252,000, assuming a 2-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.3.3 S8: Excavation and Low Temperature Thermal Desorption (Revetment)

Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments or sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500° to 800° F) can be adjusted to remove the TPH contaminants.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense the organic contaminant and water vapors out as liquids. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is presented in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area if residual metals levels are sufficiently low. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

The sequence of activities that would be performed in this alternative would consist of the following:

- Construction of the treatment unit and soil storage pads;
- Excavation of contaminated soils and transport to storage pad;
- Screen all material larger than 2 inches from soil;
- Shred material larger than 2 inches;
- Convey soils to processing system;
- Transfer treated soil to storage pad for temporary storage;
- Sample treated soil to monitor contaminant removal;
- Backfill and compaction of the excavation;
- Regrade site; and
- Off-site recycle/disposal of organic phase liquid condensate and spent carbon.

Protection of human health and the environment: The risk resulting from migration of contaminants to groundwater would be reduced because most of the contamination source would be removed.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, on site soil replacement and compaction. These requirements may require compliance to RCRA waste levels is the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Lead concentrations range between 6.38 mg/kg to 51 mg/kg. The soil may pass TCLP requirements for land disposal without additional treatment. This must be verified through testing.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the contamination would be removed in the soil, thus removing the potential groundwater contamination source, and reducing the low environmental risk identified at the Revetment Area.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the TPH contaminants toxicity and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emissions must be monitored and controlled. Remedial objective would be achieved in approximately one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: Remediation of the revetment site to comply with the 10 mg/kg TPH remediation objective involves excavating and treating 66,000 cubic yards of soil. The estimated cost for this alternative and assumptions used are presented in Table D-3.3 in Appendix D. Capital costs are estimated to be $11,487,000, and the project is estimated to take one year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-3. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be difficult because public perceptions regarding thermal treatment process.

4.4 SITE 4: PUMP STATION AREA

The Pump Station Area includes several buildings which contain three storm water pumps used to remove storm water runoff and groundwater seepage from HAA into San Pablo Bay. Three separate sites have been identified within the Pump Station area because of differences in the physical setting and the chemicals detected at each of these areas. The three sites include AST sites (PS-SS-1, 2, 3, 4, 8), the soil stockpile (PS-SS-5, 6, 7), and sediments (PS-SD-1 through 9). Remedial action alternatives will be evaluated separately for each of these sites within the Pump Station area. All three areas at the Pump Station have been included into Operable Unit 2 and additional investigation of the sediments will be conducted by the Army Corps of Engineers.

4.4.1 AST Site (Pump Station)

TPH contamination was detected in grease spots in the surface soil near the location of AST-6 (332,000 mg/kg), AST-5 (166,000 mg/kg), and AST-7 (11,100 mg/kg). One sample (PS-SS-2) near AST-6 also contained lead at 410 mg/kg and beta-benzene hexachloride (BHC) at 46.1 mg/kg. BHC concentrations at the AST site exceed its PRG (0.356 mg/kg). Benzo[a]pyrene (BAP) was detected in another sample (PS-SS-1) near AST-6 at 6.2 mg/kg which exceeds its PRG (1.1 mg/kg). Figure 4.8 and 4.9 are site maps showing the locations of TPH and of non-TPH contamination.

Results of the human health risk assessment completed as part of the EI indicate that chemicals found at the AST Sites pose a slightly elevated carcinogenic risk for current base employees and future residents because of the carcinogenic risk posed by beta-benzene hexachloride and benzo[a]pyrene. The human health risk assessment did not evaluate TPH or lead because no quantitative toxicity data exist for TPH and lead (Engineering-Science 1993). However, the samples were analyzed for BTEX but had no significant benzene, the only analyte with quantitative toxicity data. Once the soil at AST-6 is excavated, the soil will likely also require treatment for metals since the lead concentration (410 mg/kg) is high.

Two samples, TP-SD-1 and TP-SW-1, collected and reported with the Former Sewage Treatment Plant samples were from the area near AST-7 at the Pump Station. One sediment sample exceeded manganese background levels at TP-SD-1 near AST-7. The surface water or pond is also located near AST-7. Based on the risk assessment for the Pump Station, the soil and sediment near AST-7 requires remediation for manganese. Zinc was identified in the Ecological Risk Assessment ir one sediment sample, TP-SD-1. Zinc concentrations exceeded the no-cover sediment screening criteria but is less than the with-cover sediment criteria.

In summary all three AST sites require remediation. AST-5 has elevated TPH levels; AST-6 has TPH, SVOCs (BHC and BAP), and high lead concentrations; and AST-7 has TPH and zinc. The estimated volume of soil affected is 180 cubic yards at AST-5; 180 cubic yards at AST-6; and 300 cubic yards at AST-7. The area of contamination is illustrated in Figure 1.6.

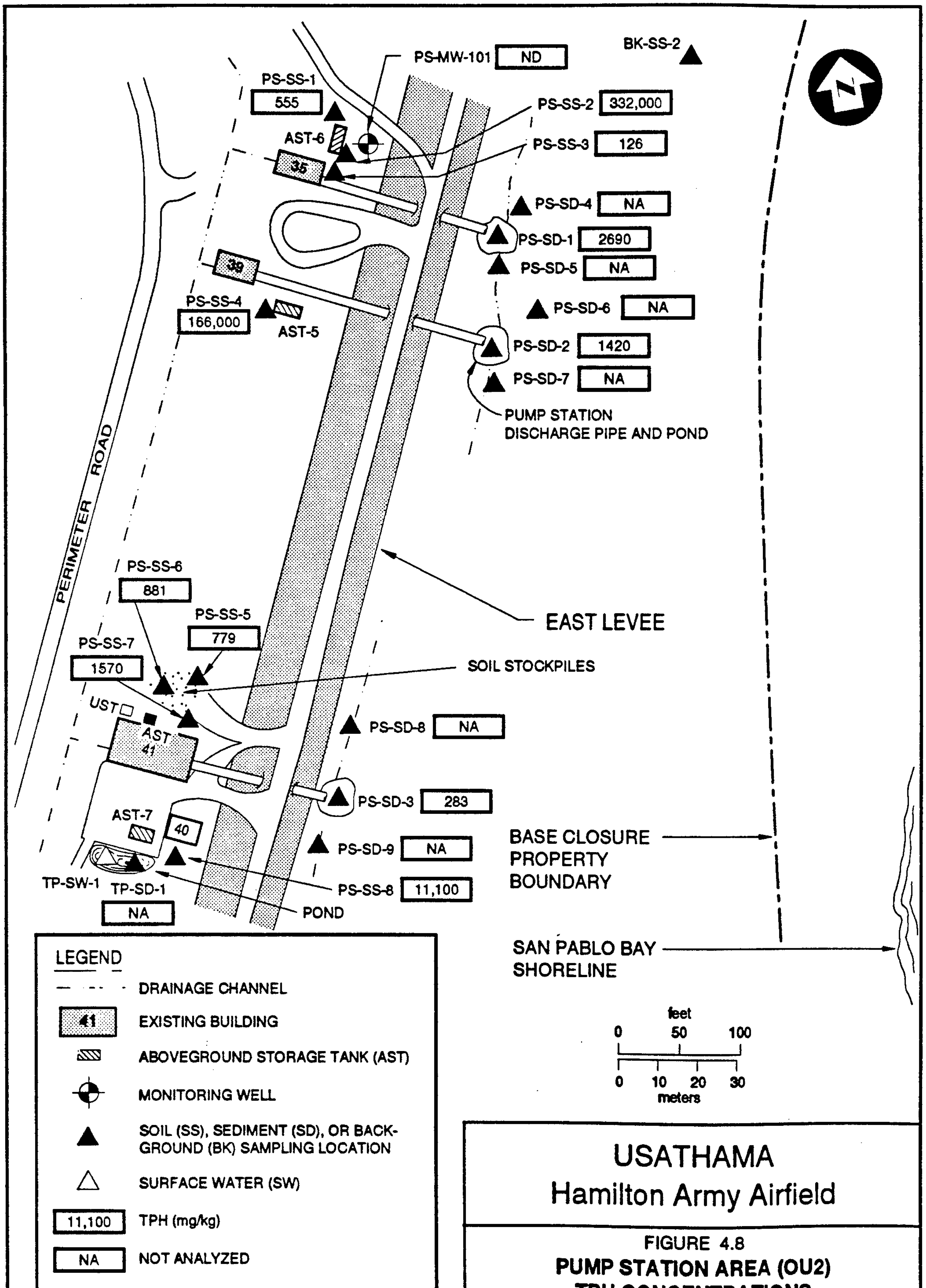

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FIGURE 4.8
PUMP STATION AREA (OU2)
TPH CONCENTRATIONS
IN SOIL AND SEDIMENT

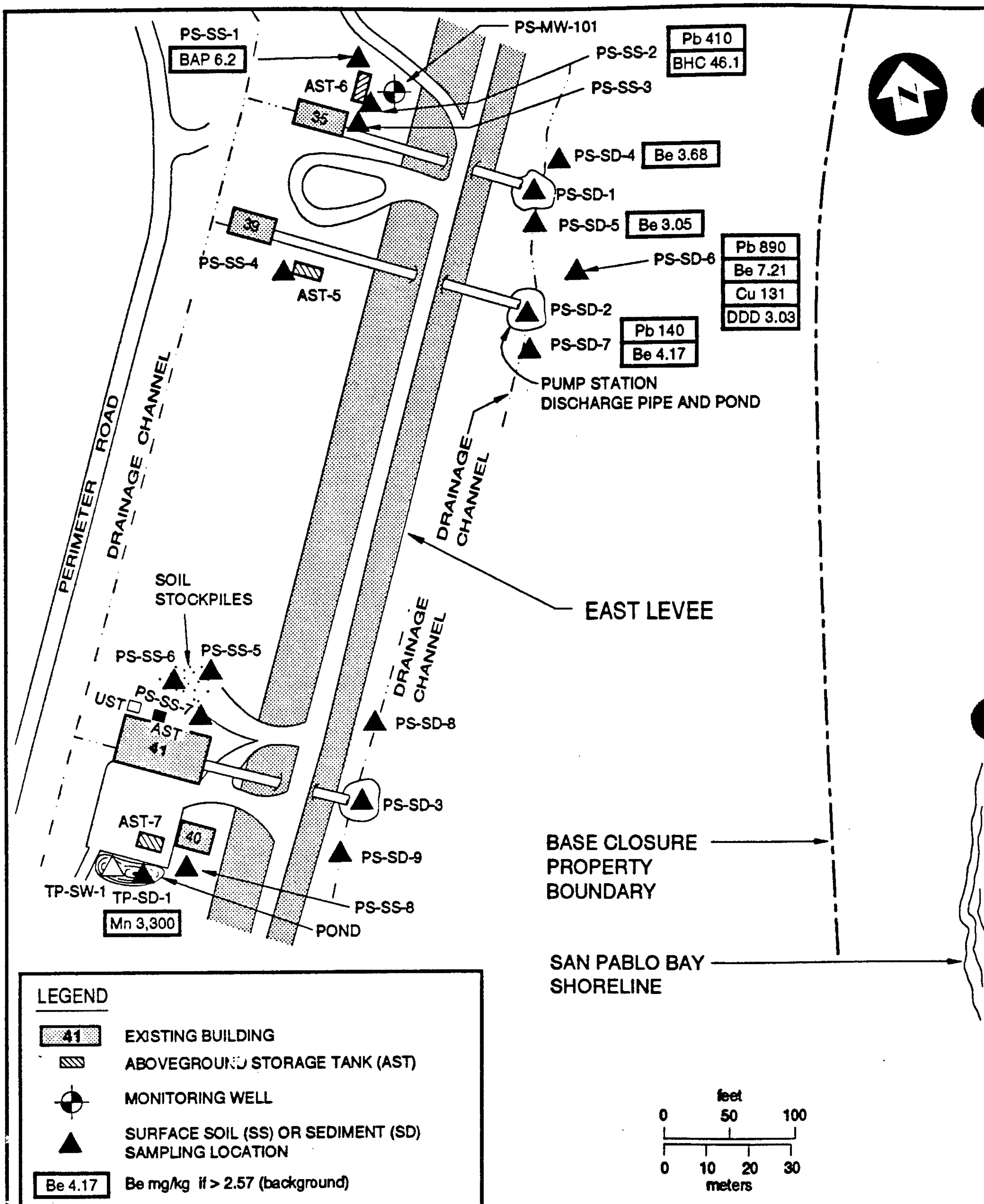

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FIGURE 4.9
PUMP STATION AREA (OU2)
NON-TPH CONTAMINANT CONCENTRATIONS IN SOIL AND SEDIMENTS EXCEEDING REMEDIATION GOAL

REV. 6 C335-22.DWG 05/04/94

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Arsenic in the surface water near AST-7 was identified by the ecological risk assessment as a potential risk (Engineering-Science 1993). Because this area was sampled at the same time as the Former Sewage Treatment Plant samples were collected, these results were reported and discussed in the EI as part of the Former Sewage Treatment Plant. AST-7 is in fact located at the Pump Station. The surface water contamination is due to nearby soil contamination and will be indirectly remediated if a soil remediation alternative is implemented by excavating and treating the soil near the pond. The water which replenishes the pond would be monitored for one year after excavation to confirm that the surface water is no longer contaminated.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S6: Excavation and Biotreatment;
- S8: Excavation and Low Temperature Thermal Desorption;
- S6/S7: Excavation and Biotreatment followed by Solidification/Stabilization;
- S8/S7: Excavation and Thermal Desorption followed by Solidification/ Stabilization;
- S9/S7: Excavation and Off-site Thermal Destruction followed by Solidification/ Stabilization; and
- S11/S7: Excavation and Chemical Oxidation followed by Solidification/ Stabilization.

The following five sections present the evaluation for the five alternatives relative to the evaluation criteria. Additionally, Figure 4.10 presents the summary of the detailed analysis of the remedial alternatives retained relative to the evaluation criteria. This figure is subdivided by types of contaminants. Certain alternatives are more applicable to specific types of contaminants and costs have been estimated assuming a given chemistry and volume for similar contamination. At least one alternative from each category needs to be selected and combined with the other selected alternatives for a final remedy. Soil washing is not effective in treating the contaminants of concern and is not considered in the alternative analysis. Soil solidification/stabilization at a recycle facility is not considered because of the high TPH concentrations detected near the AST. (But these high levels may be from testing the grease spots. Soil recycling may be viable if the non-grease spots do not have high TPH concentrations).

4.4.1.1 S1: No Action (Pump Station AST). The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. Contaminated soil left in place with TPH concentrations greater than 10 mg/kg may require long-term groundwater monitoring. Land use restrictions would be used to warn and limit receptors of human health risk and environmental risks associated with this site (Engineering-Science 1993).

FIGURE 4.10

Evaluation of Soil Remedial Alternatives
Site 4: Pump Station-AST Sites

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	○	○	○	○	◕	◕	○	○	529,000
TPH	S6: Excavation, & Biological Treatment (d, e)	◕	◕	◕	◕	◕	◕	●	●	47,000
	S8: Excavation & Thermal Desorption (d, e)	◕	◕	◕	◕	◑	◕	◕	◑	76,000
TPH and Metals	S6/S7: Excavation & Biological Treatment Followed by Solidification/ Stabilization (d, f)	◕	◕	◕	◕	◕	◕	●	●	115,000
	S8/S7: Excavation & Thermal Desorption Followed by Solidification/ Stabilization (d, f)	◕	◕	◕	◕	◑	◕	◕	◑	152,000
TPH, BHC and BAP	S9/S7: Excavation & Offsite Thermal Destruction Stabilization (g)	●	●	●	●	◕	◕	◕	◕	412,000
	S11/S7: Chemical Oxidation Solidification/ Stabilization (d, g)	◑	◑	◑	◑	◑	◕	◑	◑	161,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Groundwater Monitoring.
Monitoring Costs for Remedial Alternatives are not Included.

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for Those Soils Only Contaminated with TPH

(f) This Alternative is Considered for Those Soils Contaminated with TPH and Metals

(g) This Alternative is Considered for Those Soils Contaminated with BHC or BAP

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and risks to human health and the environment would not change. Carcinogenic risks are $2x10^{-4}$ for base employees, $3x10^{-4}$ for residents and $7x10^{-6}$ for construction workers. All three risk estimates are above the target risk of $1x10^{-6}$. This alternative does not fulfill the intent of CERCLA/SARA by providing permanent protection of human health and the environment.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Beta-benzene hexachloride and benzo[a]pyrene exceed PRGs and are responsible for the elevated human health risk at the site. There are no action-specific ARARs pertaining to a no action alternative. Location-specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990).

The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH, benzene hexachloride and benzo[a]pyrene concentrations. Location-specific ARARs are not satisfied because there is an expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative would not be effective in reducing residual contamination. Some of the contamination may naturally degrade over time, however, due to high contaminant concentrations, natural degradation may not be able to significantly reduce the concentrations to harmless levels (Engineering-Science 1993).

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-term effectiveness: There are no impacts to the community and site workers resulting from the implementation of this alternative. The contaminated soil would continue to pose a risk to human health and environment. Remedial objectives may never be achieved.

Implementability: This alternative is readily implemented technically, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-4.1.1 in Appendix D. Capital costs of $38,000 are associated with installation of wells and implementing site restrictions. Annual costs of approximately $52,000 are associated with monitoring and maintenance. The present worth costs is $529,000, assuming 30 years of operation and a 10 percent annual interest rate. These costs also apply to the no action alternatives for the Pump Station soil stockpile and sediments. A variation of the no action alternative assumes no groundwater monitoring. The cost for the alternative is $2,500 and is explained in Section 5.0.

State acceptance: Regulatory acceptance would be difficult because this alternative would not achieve the TPH cleanup goal of 10 mg/kg through treatment, and it does not address the beta-benzene hexachloride and benzo[a]pyrene contamination.

Community acceptance: Community acceptance would be difficult because the human health and ecological risks are not addressed by this alternative.

4.4.1.2 S6: Excavation and Biological Treatment (Pump Station AST). Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit and either tilling soil or drawing air through soil piles to aerate. Nutrients or microorganisms could be added to enhance degradation. Typically degradation is assumed to take 6 to 18 months. A process flow diagram is shown in Appendix E.

Biological treatment has been proven effective for degrading TPHs and may be applicable for degrading benzo[a]pyrene. Beta-benzene hexachloride is a highly chlorinated aromatic compound that is resistant to aerobic biological treatment. An alternative process such as anaerobic biotreatment might be possible, but would require additional research. The bioremediation technology has not been proven on a commercial scale or continuous basis for pesticide degradation (EPA 1988). A treatability study would be needed to determine the technology's effectiveness in degrading benzo[a]pyrene. Biological treatment alone will not remediate the metals present at AST-6 and AST-7.

Additional analysis must be performed to specify the leaching potential of the lead contamination to comply with action-specific ARARs. If the leaching potential is below landfill requirements, then the technology is implementable. If the leaching potential is above requirements, an additional technology used with biotreatment must be considered.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit possibly including vent pipe and blower;
- Excavation of contaminated soils and placement in treatment unit;
- Application of nutrients and micro-organisms if needed;
- Till soils or draw air through soil piles;
- Biodegradation of contaminated soils;
- Sample soil to monitor contaminant degradation progress;
- Analyze for TCLP RCRA metals;
- Backfill and compaction of the excavation; and
- Regrade site.

Protection of human health and the environment: Bioremediation is effective for TPH and could be used to treat soils that do not contain BHC or BAP. Biodegradation has not been proven to be successful on a commercial scale for degrading pesticide contamination. Therefore, this technology may not provide overall protection of human

health, and the environment. A treatability study is needed to determine bioremediation's effectiveness in degrading beta-benzene hexachloride and benzo[a]pyrene.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Preliminary remediation goals (PRGs) have been estimated for those analytes where EPA risk data is available. Beta-benzene hexachloride exceeds its PRG of 0.356 mg/kg and benzo[a]pyrene exceeds its PRG of 1.1 mg/kg. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Bioremediation is unlikely to be effective for beta-benzene hexachloride. A treatability study is needed to determine if bioremediation will effectively remediate benzo[a]pyrene. Under favorable conditions the TPH cleanup goal may be attained however, pilot test is recommended to determine degradation rates. An alternative treatment should be used if necessary to treat BHC and BAP contaminated soils in order to comply with chemical specific ARARs. Biological treatment alone will not remediate the metals present at AST-6 and AST-7.

All the action-specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action-specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto the land until the hazardous constituents are treated with a specific treatment technology or until constituent concentrations are reduced below specific levels. The soil near PS-SS-2 (AST-6) has relatively high lead concentrations and additional treatment may be necessary.

Location-specific ARARs (critical habitat and/or endangered or threatened species) would be satisfied because the expected environmental risk from TPH contamination would be reduced.

Long-term effectiveness and permanence: Bioremediation may not be protective in the long-term because it has not been proven to be successful on a commercial scale for degrading pesticide contamination. Bioremediation is effective for TPH and could be used to treat soils that do not contain BHC or BAP.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the toxicity and volume of TPH contamination but be only somewhat effective in reducing the toxicity, mobility, or volume of the pesticide contamination. An alternate technology could be used to treat the BHC and BAP contaminated soil.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. There is minimal risk to the public during remediation. Remediation would be complete in approximately 2 years, but not all contaminants could

likely meet the cleanup goals. An alternate technology could be used to treat the BHC and BAP contaminated soil.

Implementability: Bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. However a treatability study may need to be completed to determine bioremediation's effectiveness in degrading benzo[a]pyrene beta-benzene hexachloride. An alternate technology could be used to treat the BHC and BAP contaminated soil.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.1.2 in Appendix D. Remediation of soils contaminated with only TPH (AST-5) involves excavating and treating 180 cubic yards of soil. Capital costs are estimated to be $25,000 and annual costs are estimated to be $12,800 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is estimated to be $47,200, assuming a 2-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance may be difficult because the technology has not been proven on a commercial scale or continuous basis for the degradation of pesticides (EPA 1988). However, bioremediation is effective in treating TPH and would likely be acceptable for treating soils that do not contain BHC or BAP.

Community acceptance: Community acceptance may be difficult because the effectiveness of the pesticide degradation is not known. The community would likely accept bioremediation for the treatment of soils that do not contain BAP or BHC.

4.4.1.3 S8: Excavation and Low Temperature Thermal Desorption (Pump Station - AST). Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments or sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The technology would be operated at the high end of the temperature scale for low temperature thermal desorption and at long residence times to drive off volatile pesticide contaminants.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense the organic contaminant and water vapors out as liquids. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area if residual lead levels are sufficiently low. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

Additional analysis must be performed to specify the leaching potential of the lead contamination to comply with action-specific ARARs. If the leaching potential is below landfilling requirements, then the technology is implementable. If the leaching potential

is above requirements, an additional technology used with thermal desorption must be considered.

Low temperature thermal desorption is not likely to be effective for the two pesticide contaminants identified in the Pump Station soils. The successful application of thermal desorption technology depends on contaminants being somewhat volatile (EPA 1990c). Both BHC and BAP have especially low vapor pressure and very likely will not desorb from the soil. Additional technology such as soil stabilization/solidification is needed to treat metal contaminants present of AST-6 (lead) and AST-7 (zinc).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Analyze for TCLP RCRA metals
- Backfill and compaction of the excavation
- Regrade site, and
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: This technology does not provide overall protection of human health for soils contaminated with BHC or BAP. However, low temperature thermal desorption has been proven to be successful on a commercial scale for removing TPH contamination from soil.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. It is also effective on residual VOCs and SVOCs. Beta-benzene hexachloride and benzo[a]pyrene both exceed their respective PRGs (0.356 mg/kg and 1.1 mg/kg). Low temperature thermal desorption is not effective for beta-benzene hexachloride or benzo[a]pyrene. Under favorable conditions the TPH remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm. An alternative treatment might be used if necessary to treat BHC and BAP contaminated soils in order to comply with chemical specific ARARs. Additional technology would be needed to meet remediation goals for metals present at AST-6 and AST-7.

With proper technology implementation, action-specific ARARs that apply to low temperature thermal desorption would be met. Action-specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location-specific ARARs (critical habitat/or and endangered or threatened species) would be satisfied because the expected environmental risk from TPH contamination would be reduced.

Long-term effectiveness and permanence: Low temperature thermal desorption would not be protective in the long-term because it is ineffective for removing BHC and BAP contamination from soil. Low temperature thermal desorption is effective for TPH and could be used on soils that do not contain BHC or BAP.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption is not effective in reducing the toxicity, mobility, or volume of the pesticide contamination. It would reduce the volume of TPH contamination. An alternative technology could be used to treat soils that contain BHC or BAP.

Short-term effectiveness: Site workers may be exposed to low level of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emission must be monitored and controlled. The TPH contaminants would be removed. An alternative technology could be used to treat soils that contain BHC or BAP. Remediation period is expected to be approximately one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes, especially with pesticides involved. An alternative technology could be used to treat soils that contain BHC or BAP.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.1.3 in Appendix D. Remediation of soils contaminated with only TPH (AST-5) involves excavating and treating 180 cubic yards of soil. Capital costs are estimated to be $76,200 and the project is estimated to take 4 months. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is equal to the capital cost.

State acceptance: Regulatory acceptance may be difficult because low temperature thermal desorption is not effective for treating benzene hexachloride, benzo[a]pyrene or metals. In addition it would be difficult to acquire a permit to treat soils containing chlorinated compounds because of potential air emissions. However, thermal desorption is effective in treating TPH and would likely be acceptable for soil near AST-5.

Community acceptance: Community acceptance may be difficult because the process is not effective in treating benzene hexachloride, and benzo[a]pyrene. Thermal desorption is effective in treating TPH and would likely be acceptable. However, the public does not favor thermal treatment processes in their communities.

4.4.1.4 S6/S7: Excavation and Biological Treatment followed by Solidification/ Stabilization (Pump Station - AST). Biological treatment followed by solidification/ stabilization is a treatment alternative effective in treating organic contaminants by biological treatment followed by residual metals management. The process begins with conventional biological treatment. Soils or sediments are excavated and placed in a controlled treatment unit. The soil is aerated either mechanically by tilling or passively by drawing air through vent pipes placed in soil piles. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade a wide range of organics including TPH. Nutrients or special microorganisms can also be added to enhance the remediation process.

Upon completion of the bioremediation, solidification additives are mixed with the soil still contaminated with residual metals. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the Toxicity Characteristic Leaching Procedure TCLP test, it can be returned to the excavation on site. A process flow diagram is shown in Appendix E.

Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils and nutrients as needed
- Biodegradation of contaminated soils
- Sampling of soil to monitor contaminant degradation progress
- Application of solidification agents
- TCLP metals analysis
- Backfilling and compaction of the excavation, and
- Regrading the site

Protection of human health and the environment: Biodegradation followed by solidification/stabilization would be effective in protecting human health and the environment against TPH and heavy metals and may be applicable for degrading benzo[a]pyrene. However, beta-benzene hexachloride is a highly chlorinated aromatic compound that is resistant to aerobic biological treatment. Beta-benzene hexachloride may be treated by solidification/stabilization, but a treatability test would be needed to confirm.

Compliance with ARARs: Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil and could be used for treating soils that do not contain BHC or BAP. Under favorable conditions the TPH remedial action objective may be attained. A treatability study is recommended to determine degradation rates and to confirm treatment effectiveness in treating the pesticides. An alternative treatment might be used if necessary to treat BHC or BAP contaminated soil. Bioremediation/Solidification could be used to treat sediments that do not have pesticides. Solidification/Stabilization would fulfill lead, zinc and other metal requirements.

All action-specific ARARs that apply to excavation, biotreatment and solidification/stabilization would be met with proper technology implementation. Action-specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the sediment is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). Additionally, if the sediment is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Bioremediation followed by solidification/stabilization would be protective in the long-term because TPH would be removed in the soil and the heavy metals would be immobilized. The stabilization process may be effective for BAP and BHC but this would need to be confirmed by a treatability test. An alternate technology could be used to treat these pesticides

Reduction of toxicity, mobility, or volume through treatment: Bioremediation followed by solidification/stabilization would reduce the toxicity, mobility, and volume of TPH, metals, and pesticides.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, which could be minimized with engineering controls and personal protection equipment. There is minimal risk to the public during remediation. Cleanup time is expected to be approximately two years.

Implementability: Bioremediation followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.1.4 in Appendix D. Remediation of soil contaminated with TPH and metals involves excavating and treating 300 cubic yards of soil near AST-7. Capital costs are estimated to be $75,000 and annual costs are estimated to be $23,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is estimated to be $115,000, assuming a 2-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH and metals. Another technology could be selected for treating soil contaminated with benzo[a]pyrene and beta benzene hexachloride.

Community acceptance: Community acceptance should be attainable due to this technology's proven effectiveness in remediating TPH and metals. Another technology could be selected for treating soil contaminated with Benzo[a]pyrene and beta benzene hexachloride.

4.4.1.5 S8/S7: Excavation and Low Temperature Thermal Desorption followed by Solidification/ Stabilization (Pump Station - AST). Low temperature thermal desorption followed by solidification/stabilization is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Solidification additives are then mixed with the treated soils from the thermal desorption unit. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

Low temperature thermal desorption is not likely to be effective for the two pesticide contaminants identified in the Pump Station soils. The successful application of thermal desorption technology depends on contaminants being somewhat volatile (EPA 1990c). Both BHC and BAP have especially low vapor pressure and very likely will not desorb from the soil. Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites for similar applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Application of solidification agents
- TCLP metals analysis
- Backfill and compaction of the excavation
- Regrade site
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: Low temperature thermal desorption followed by solidification/stabilization would be effective in protecting human health and the environment against TPH and heavy metals. A treatability test is needed to confirm if solidification/stabilization is effective in treating BHC and BAP.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection for the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm. Low temperature thermal desorption is not effective for BHC or BAP. Solidification/stabilization has demonstrated effectiveness in managing heavy metals. Solidification/stabilization may be effective in immobilizing BHC and BAP, however, a treatability study is needed to confirm this.

With proper technology implementation, action-specific ARARs that apply to low temperature thermal desorption followed by solidification/stabilization would be met. Action-specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement and compaction. These ARARs may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic of a hazardous waste. Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands,

critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption followed by solidification/stabilization would be protective in the long-term at AST-7 because TPH would be removed and the heavy metals would be stabilized. Solidification/stabilization may be effective in treating low concentrations of BAP and BHC. However, it has not been proven to be successful on a commercial scale. A treatability study would need to be conducted to determine the long-term effectiveness.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption followed by solidification/stabilization would reduce the toxicity, mobility, and volume of TPH and heavy metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, which may be minimized with engineering controls and personal protection equipment. Air emissions must be monitored and controlled. Remediation period is expected to be one year.

Implementability: Low temperature thermal desorption followed by solidification/ stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes. The air board would likely be very reluctant to permit thermal desorption of soils contaminated with halogenated compounds such as BHC.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.1.5 in Appendix D. Remediation of soils contaminated with TPH and metals involves excavating and treating 300 cubic yards of soil at AST-7. Capital costs are estimated to be $152,000 the project is estimated to take 6 months. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance is not likely for soils contaminated with BHC or BAP. State agencies may accept thermal desorption for those soils that are not contaminated with chlorinated compounds provided an alternate treatment is selected.

Community acceptance: Community acceptance may be difficult because of perception regarding thermal treatment processes in their communities.

4.4.1.6 S9/S7: Excavation and Off-site Thermal Destruction followed by Solidification/ Stabilization (Pump Station - AST). This alternative is initiated with conventional excavation of the contaminated sediment followed by off-site transportation which may be completed by truck or rail. Treatment of contaminated soil involves incineration at high temperature (>2000° F) to destroy and remove contaminants. The treatment facility is responsible for and will certify the destruction of the waste, treatment of the off-gas, and final disposal of incinerator residuals (ash). A process flow diagram is shown in Appendix E.

Disposal of the incineration ash would require solidification if heavy metal concentrations exceed action-specific ARARs requiring treatment of the residual ash prior to land disposal with solidification/stabilization. The process involves the addition of solidification additives mixed with the residual ash. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation site.

A significant portion of the cost for off-site incineration is transportation, because California does not have a commercial incineration facility. For costing purposes, the Rollins Facility in Deer Park, Texas was selected as the designated incineration facility.

The sequence of activities that would be performed in this alternative consist of the following:

- Excavation of contaminated soils
- Transportation of contaminated soils to off-site incineration facility
- Incineration
- Application of solidification agents to residual ash
- TCLP metals analysis
- Disposal of solidified ash
- Backfill and compaction of the excavation, and
- Regrade site

Protection of human health and the environment: This alternative provides protection for human health and the environment by providing a proven remedy that destroys the organic contaminants present and successfully manages the remaining inorganics, providing a long-term permanent solution.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Preliminary remediation goals (PRGs) have been calculated for those analytes where EPA risk data is available. Beta-benzene hexachloride exceeds its PRG of 0.356 mg/kg and benzo(a)pyrene exceeds it PRG of 1.1 mg/kg. Off-site incineration is proven to be an effective treatment for the remediation of TPH, benzo[a]pyrene and beta-benzene hexachloride contaminated in soil. Solidification/stabilization has demonstrated effectiveness in managing heavy metals.

Action-specific ARARs that apply to off-site incineration followed by solidification/ stabilization include excavation, air emissions, and Department of Transportation requirements. Additionally, the designated incineration facility will be responsible for fulfilling action-specific ARARs that apply to their process. These ARARs include incineration ARARs as presented in Appendix F, Table F-2, which would be applicable if

the waste is determined to be a RCRA hazardous waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). All action-specific ARARs may be met with proper technology implementation.

This alternative is consistent with location-specific ARARs for wetlands, critical habitats and endangered species protection.

Long-term effectiveness and permanence: This alternative would result in complete destruction of all organics including beta-benzene hexachloride, benzo[a]pyrene and TPH. The heavy metals would be effectively managed by solidification/stabilization.

Reduction of toxicity, mobility, or volume through treatment: Off-site incineration would be effective in reducing the toxicity, mobility, or volume of the beta-benzene hexachloride, benzo[a]pyrene and TPH contamination. The mobility of the heavy metals contamination would be effectively managed by solidification/stabilization.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation and material handling. However, with engineering controls and personal protection equipment the technology can be implemented effectively. The off-site facility should meet RCRA requirements and be protective of the community. Remediation time is very short.

Implementability: Off-site incineration may be readily implemented as it is a proven technology, and it can be reliably operated. However, RCRA facility capacity may be limited.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.1.6 in Appendix D. Remediation of soils contaminated with BHC and BAP involves excavating and treating 180 cubic yards of soil near AST-6. Capital costs are estimated to be $412,000. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is equal to the capital cost.

State acceptance: Regulatory acceptance should be attainable because this alternative would result in complete destruction of beta-benzene hexachloride, and benzo[a]pyrene and management of the inorganics by solidification/stabilization. However, the State favors on site treatment and disposal if possible.

Community acceptance: Community acceptance should be attainable because of public perceptions regarding active treatment of contaminants and the reduction of long-term risk. The public would prefer to avoid transporting hazardous material and instead treat the soil on site if possible.

4.4.1.7 S11: Excavation and Chemical Oxidation Followed by Solidification/ Stabilization (Pump Station - AST). Chemical oxidation processes are an effective remedial alternative for the treatment of organic contaminants by transforming contaminants into less toxic substances. Oxidizing agents such as ozone and hydrogen peroxide are added to soil to facilitate organic contaminant degradation. The oxidizing agents attack carbon-carbon bonds oxidizing the organic species to carbon dioxide and

water. In the process, soils would be mixed with the oxidizing agent and placed into a controlled treatment unit for continued contaminant degradation. A process flow diagram is shown in Appendix E.

Chemical oxidation may not be effective in treating BHC and BAP. Chemical oxidation was not included as an applicable technology for the treatment of beta-benzene hexachloride or benzo[a]pyrene structural functional groups (EPA 1990c). Thermal destruction was the only technology recommended for BHC. If this alternative is selected, a treatability study would need to be completed to determine the technology's effectiveness in degrading beta-benzene hexachloride and benzo[a]pyrene. The volume of soil containing BHC or BAP is small and an alternative treatment technology could be used to remediate these soils.

Solidification/stabilization is a demonstrated technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of sediment storage pads and processing system
- Convey soils to processing system for application of oxidizing agents
- Placement of sediments into treatment unit
- Sample treated sediments to monitor contaminant removal
- Application of solidification agents
- TCLP metal analysis
- Backfill and compaction of the excavation
- Regrade site

Protection of human health and the environment: Chemical oxidation is not a proven technology on a commercial scale for removing pesticide contamination from soil. Therefore, this technology is not known to provide overall protection of human health. A treatability study could be completed to determine the technology's effectiveness in treating pesticides. Chemical oxidation is effective for TPH and could be used to treat soils that do not also contain BHC or BAP.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Preliminary remediation goals (PRGs) have been calculated for those compounds where EPA risk data is available. Beta-benzene hexachloride exceeds its PRG of 0.356 mg/kg and benzo[a]pyrene exceeds its PRG of 1.1 mg/kg. Chemical oxidation has been proven to be an effective treatment for the remediation of TPH contamination in soil. However, chemical oxidation may not be effective in reducing TPH concentrations to 10 mg/kg. The 10 mg/kg TPH cleanup goal was not achieved in a recent remediation effort at the POL Area using chemical oxidation (International Technologies 1991). A treatability study would be needed to

confirm effectiveness in treating TPH. In addition, a treatability study is needed to evaluate the effectiveness of chemical oxidation on BHP and BAP.

With proper technology implementation, action-specific ARARs that apply to excavation and chemical oxidation would be met. Action-specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil if determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location-specific ARARs (critical habitat/or and endangered or threatened species) may not be satisfied because the expected environmental risk from TPH contamination would not be reduced.

Long-term effectiveness and permanence: Chemical oxidation may not be protective in the long-term because it has not been proven to be successful on a commercial scale for removing BHC or BAP contamination from soil nor has it been demonstrated that 10 mg/kg TPH can be achieved on a commercial scale. A treatability study is recommended. Solidification/stabilization would reduce the mobility and impact of lead, zinc and other contaminants.

Reduction of toxicity, mobility, or volume through treatment: Chemical oxidation may not be effective in reducing the toxicity, mobility, or volume of the pesticide contamination. It would reduce the toxicity, mobility, and volume of the TPH contamination. An alternative technology could be used to treat the BHC and BAP contaminated soil.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Remediation period is approximately one year. However, effectiveness of treatment on pesticides has to be determined and it should be demonstrated whether the 10 mg/kg TPH cleanup goal can be achieved.

Implementability: Chemical oxidation and solidification/stabilization technologies may be readily implemented as they are proven technologies, components are commercially available, and they can be reliably operated. A treatability study would be needed to evaluate the effectiveness of chemical oxidation and solidification/stabilization on TPH, BHC, BAP, and metals.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.1.7 in Appendix D. Remediation of soils contaminated with BHC, BAP, and TPH involves excavating and treating 180 cubic yards of soil at AST-6. Capital costs are estimated to be $161,000. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is equal to the capital cost.

State acceptance: Regulatory acceptance may be difficult because no reference data was obtained stating that chemical oxidation has been proven on a commercial scale for the removal of pesticides or reducing TPH levels to 10 mg/kg. However, regulatory acceptance may be obtained if the treatability study is successful.

Community acceptance: Community acceptance may be difficult because the effectiveness of the pesticide degradation is not known. However, chemical oxidation would likely be acceptable for treating TPH soils that are not contaminated with BAP or BHC if the treatability study demonstrates that 10 mg/kg TPH can be achieved.

4.4.2 Soil Stockpile (Pump Station)

The soil stockpile consists of excavated soil from a previous remedial activity associated with a leaking storage tank from AST-7. Surface soil samples collected from the stockpile indicate that TPH is the only contaminant present. All other analytes detected were below ARARs, PRGs, and cleanup levels. Surface soil TPH contaminant concentrations range from 779 to 1,570 mg/kg. The estimated volume of the soil stockpile is 700 cubic yards, and the area of contamination is shown in Figure 1.6.

An unnumbered UST and AST are located next to the stockpile soil. The condition of the UST is unknown. Soil samples were not collected near either tank. If contamination is present, it is presumed to be TPH and the area will be addressed as part of the stockpile remediation. Confirmatory samples will be taken in the area of the UST and AST to ensure cleanup goals are met and to verify that other contaminants are not present.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S6: Excavation and Biotreatment; and
- S8: Excavation and Low Temperature Thermal Desorption.

Since the soil is already stockpiled, excavation only refers to moving of soil pile. The following three sections present the evaluation for the three alternatives relative to the evaluation criteria. Additionally, Figure 4.11 presents the summary of the detailed analysis of the four remedial alternative retained relative to the evaluation criteria.

4.4.2.1 S1: No Action (Pump Station - Stockpile). The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. Contaminated soil left in place with TPH concentrations greater than 10 mg/kg may require long-term groundwater monitoring. Land use restrictions are necessary to warn and limit receptor access to the site.

Protection of human health and the environment: The no action alternative would not fulfill the intent of CERCLA/SARA by providing permanent protection of human health and the environment.

FIGURE 4.11

Evaluation of Soil Remedial Alternatives

Site 4: Pump Station-Soil Stockpile

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	◔	◔	◔	○	◕	◕	◔	◔	529,000
	S6: Excavation & Biological Treatment (d)	◕	◕	◕	◕	◕	◕	●	●	111,000
	S8: Excavation & Thermal Desorption (d)	◕	◕	◕	◕	◑	◕	◕	◑	171,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

REV. 8 C336-05.DWG 04/28/94

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Location-specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). There are no action-specific ARARs pertaining to a no action alternative.

The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Location-specific ARARs are not satisfied because there is an expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative would not be directly effective in reducing residual TPH contamination. The contamination may naturally degrade over time, however this cannot be accurately predicted.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-term effectiveness: With the no action alternative, there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative. However, contamination has the potential to migrate to groundwater.

Implementability: This alternative is readily implemented technically. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative is presented in Table D-4.2.1 in Appendix D. Capital costs of $38,000 are associated with installation of wells and implementing site restrictions. Annual costs of approximately $52,000 are associated with monitoring and maintenance, which account for present worth costs of $529,000, assuming 30 years of operation and a 10 percent annual interest rate. These costs also apply to the no action alternative for the Pump Station AST sites and sediments. A variation of the no action alternative assumes no groundwater monitoring. The cost for this alternative is $2,500 and is explained in Section 5.

State acceptance: Regulatory acceptance may be difficult because this alternative would not achieve the TPH cleanup goal of 10 mg/kg through treatment.

Community acceptance: Community acceptance may be difficult to obtain due to public perceptions, regarding land use and lack of active treatment of contaminants.

4.4.2.2 S6: Excavation and Biotreatment (Pump Station - Stockpile). Biological treatment of contaminated soil has been proven effective for degrading TPHs. Biological treatment would consist of taking the excavated soil and placing this soil in a controlled treatment unit. The soil is aerated either mechanically by tilling, or passively by drawing air through vent pipes placed in the soil piles. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade TPH. Nutrients or special

microorganisms can also be added to enhance the remediation process. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit (possibly including vent pipes and blowers)
- Transfer soil pile into the treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or draw air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Backfill and compaction of the excavation
- Regrade site

Protection of human health and the environment: The low risk to the environment, and the risk resulting from migration of TPH contaminants to groundwater would be reduced because most of the TPH contamination source would be degraded.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide for protection of the underlying groundwater. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. A pilot study is recommended to determine degradation rates.

All the action-specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action-specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste level if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto the land until the hazardous constituents are treated with a specific treatment technology or until constituent concentrations are reduced below specific levels.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Bioremediation would be protective in the long-term because most of the TPHs would be degraded in the soil, thus removing the potential groundwater contamination source, and reducing the environmental risk.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the TPH contaminants toxicity and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. There is no expected risk to the community. Remediation will destroy the chemicals of concern. Estimated cleanup time is two years.

Implementability: Bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.2.2 in Appendix D. Remediation of soils contaminated with only TPH involves excavating and treating 700 cubic yards of soil. Capital costs are estimated to be $32,000 and annual costs are estimated to be $46,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is estimated to be $111,000, assuming a 2-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.4.2.3 S8: Excavation and Low Temperature Thermal Desorption (Pump Station - Stockpile). Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments or sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800° F) can be adjusted to remove the TPH contaminants.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment end products include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area if residual metals levels are sufficiently low. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pad

- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Backfill and compaction of the excavation
- Regrade site
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: The risk to the environment, and the risk resulting from migration of TPH contaminants to groundwater would be reduced because most of the TPH contamination source would be removed.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm.

With proper technology implementation, action-specific ARARs that apply to low temperature thermal desorption would be met. Action-specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the TPH contamination would be removed in the soil, thus removing the potential groundwater contamination source.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the TPH contaminants toxicity, mobility and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be

implemented effectively. Air emission must be monitored and controlled. Remediation is expected to be complete in one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.2.3 in Appendix D. Capital costs are estimated to be $171,000 and the project is estimated to take 4 months. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is equal to the capital cost.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be difficult because public perception regarding thermal treatment process.

4.4.3 Sediments (Pump Station)

TPH was analyzed in three sediment samples, PS-SD-1, 2, and 3, each taken near the discharge end of the relief pipe. Concentrations ranged from 283 mg/kg to 2690 mg/kg at PS-SD-1. Very likely TPH is predominant throughout the sediment in the drainage channel. Beryllium, and arsenic were detected in sediments at levels that exceed their PRGs. Arsenic concentrations were all within background levels. Four samples exceeded background levels for beryllium (PS-SD-4, 5, 6, 7). Pesticides, DDT (0.25 mg/kg) and DDD (3.03 mg/kg) were detected in three samples. Soil samples did not exceed PRGs for DDT and only one sample, PS-SD-6, exceeded the DDD PRG. This same sample (PS-DS-6) also contains 890 mg/kg of lead which exceeds the DTSC lead criteria.

Results of the human health risk assessment completed as part of the EI identified a moderate carcinogenic risk due to potential exposure to arsenic, beryllium and copper (Engineering-Science 1993). Copper did not exceed its PRG of 1.08×10^4 anywhere on the site and exceeded the upper background limit of 94.8 mg/kg only at PS-SD-6. Arsenic is within background levels for soils in the wetland areas. The total risk for the other detected analytes including DDT and DDD is very low (less than 1×10^{-6}). Figure 4.8 and 4.9 are site maps showing the locations of contamination.

Other analytes of concern identified by the ecological risk assessment include lead, manganese, nickel, zinc, DDD and DDT. As discussed in Section 2, there are two sets of proposed sediment screening criteria: one without a cover and the other with a cover. The cover would consist of 3 feet of soil/sediment that meets the no-cover criteria. All the sediment sample points exceed the no-cover criteria for manganese. Although nickel and zinc exceed the no-cover criteria at all but one sample site each, the only sites that exceed background are at PS-SD-4, 6, and 7 for both zinc and nickel and additionally at PS-SD-8 nickel exceeds background. DDT exceeds the no-cover criteria at PS-SD-1 and

there are no DDD criteria proposed by the SFRWQCB for sediment. A considerable volume of sediment would require excavation and treatment in order to comply with the no-cover criteria.

The criteria for sediments if a cover is applied is higher and the volume requiring excavation and treatment is much less. Sample area PS-SD-6 and 7 exceed lead, nickel and zinc criteria and sample area PS-SD-4 and 8 exceed the nickel criteria. DDT exceeds the criteria at PS-SD-1. These are the same sites that exceed background and the no-cover criteria. Manganese exceeds the ecological risk criteria throughout the site and exceeds background in three samples, PS-SD-6, 7, and 8. Manganese, however, is a risk for vegetation only if the pH is below 5 or above 8. Although no pH data was determined for the sediment, the drainage ditch is thriving with a variety of plant life and manganese is apparently not toxic under existing conditions. In order to comply with the proposed sediment criteria sediment near sample areas PS-SD-1, 4, 6 and 7 (north) and PS-SD-8 (south) need to be excavated and the area in question covered with 3 feet of clean soil/sediment. The excavated sediment would require treatment prior to disposal which also treats for the organic contaminants present. The cap material could consist of treated sediments or possibly treated soil from other sites at HAA. Less sediment would require excavation and treatment for the with-cover option.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S2/S6/S7: Excavation and Biotreatment followed by Solidification/Stabilization;
- S2/S8/S7: Excavation and Low Temperature Thermal Desorption followed by Solidification/Stabilization;
- S2/S9/S7: Excavation and Off-site Thermal Destruction followed by Solidification/Stabilization;
- S2/S11/S7: Excavation and Chemical Oxidation followed by Solidification/ Stabilization; and
- S2/S12: Excavation and Soil Washing.

The estimated volume of contaminated sediment is 22,200 cubic yards. The area requiring excavation and treatment at the Pump Station is shown in Figure 1.6. Based on data collected in the EI, about half the area (north half) was found to be contaminated with TPH, pesticides, and metals and the remainder (south half) was found to contain TPH. Additional investigation by the Army Corp of Engineers (Corps 1994) found additional SVOCs and metals at the southern half of the Pump Station sediments. About 33,300 cubic yards of cover material would be placed over the excavated area.

The following five sections present the evaluation for each alternative relative to the evaluation criteria. This evaluation is based on findings in the EI. The Pump Station is assigned to Operable Unit 2. A modified Alternatives Analysis will be needed to account for the additional contamination found during the supplemental EI study.

Figure 4.12 presents the summary of the detailed analysis of the five remedial alternative retained relative to the evaluation criteria. This figure is subdivided by types of contaminants. Certain alternatives are more applicable to specific types of contaminants and costs have been estimated assuming a given chemistry and volume for similar contamination. At least one alternative from each category needs to be selected and combined with the other selected alternatives for a final remedy. Solidification/ stabilization by itself was not considered since this technology is not effective given the high concentrations of TPH in the sediments.

4.4.3.1 S1: No Action (Pump Station - Sediment). The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for sediment at this site would consist of no remedial activities. The sediment would remain in place. Contaminated sediment left in place with TPH concentrations greater than 10 mg/kg may require long-term groundwater monitoring. Land use restrictions would be used to warn and limit receptors access to the site due to the human health risk and environmental risks associated with this site.

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to human health and the environment would not change. This alternative does not fulfill the intent of CERCLA/SARA by providing permanent protection of human health and the environment.

Compliance with ARARs: The chemicals of concern include heavy metals, TPH, DDT, and DDD. A cleanup goal for TPH (10 mg/kg) has been assumed to provide protection of the underlying groundwater. Based on DTSC guidelines, the maximum inorganic lead levels that can be left in place is 535 mg/kg. DDD exceeds the preliminary remediation goal of 2.67 mg/kg at PS-SD-6. Beryllium exceeds PRG and background levels. Although copper does not exceed PRGs, the carcinogenic risk from ingestion exceeds 1×10^{-6}. One copper sample (PS-SD-6) exceeded background levels. Sediments near PS-SD-1, 4, 6, 7 and 8 exceed the proposed sediment screening criteria assuming the area will be covered with 3 feet of backfill. The no action alternative does not satisfy cleanup goals or PRGs.

There are no action-specific ARARs pertaining to a no action alternative. Location-specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990).

The no action alternative would not be in compliance with the remedial action objective because of the elevated contaminant concentrations. The total risk at the site exceeded 1×10^{-6}. Location-specific ARARs are not satisfied because there is a expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative would not be effective in reducing contamination. TPH contamination may naturally degrade over

FIGURE 4.12

Evaluation of Soil Remedial Alternatives

Site 4: Pump Station-Sediments

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	No	No	No	No	Low	Moderate	No	No	529,000
TPH and Metals	S6/S7: Excavation & Biological Treatment Solidification/ Stabilization (e)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	162,000
	S8/S7: Thermal Desorption Solidification/ Stabilization (d, e)	Moderate	Moderate	Moderate	Moderate	Partial	Moderate	Moderate	Partial	212,000
TPH, Pesticides and Metals	S9/S7: Off-site/ Thermal Destruction Solidification/ Stabilization (f)	High	High	High	High	Moderate	Moderate	Moderate	Moderate	49,890,000
	S11/S7: Chemical Oxidation Solidification/ Stabilization (d, f)	Low	Low	Low	Partial	Partial	Partial	Partial	Partial	6,102,000
	S12: Soil Washing (d, f)	Partial	Moderate	Partial	Partial	Partial	Partial	Moderate	Moderate	5,675,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for Those Sediments Only Contaminated with TPH and Metals

(f) This Alternative is Considered for Those Sediments Contaminated with DDT or DDD and Metals

REV. 7 C336-06.DWG 04/28/94

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time, however this cannot be accurately predicted. Beryllium, copper and lead would continue to impact the environment and potentially could impact groundwater. Metals identified in the EI ecological risk assessment will remain.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants.

Short-term effectiveness: There are no impacts to the community and site workers resulting from the implementation of this alternative. The contaminated soil would continue to pose a risk to human health and environment. Remedial objective may never be achieved.

Implementability: This alternative is readily implemented technically, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-4.3.1. Capital costs of $38,000 are associated with installation of wells and implementing site restrictions. Annual costs of approximately $52,000 are associated with monitoring and maintenance, which account for present worth costs of $529,000, assuming 30 years of operation and a 10 percent annual interest rate. These costs also apply to the no action alternatives for the Pump Station AST sites and soil stockpile. A variation of the no action alternative assumes no groundwater monitoring. The cost for this alternative is $2,500 and is explained in Section 5.

State acceptance: Regulatory acceptance would be difficult because this alternative would not achieve the TPH cleanup goal of 10 mg/kg through treatment, it does not address the lead contamination which exceeds the DTSC cleanup criteria, and the overall risk at the site would exceed 1×10^{-6}.

Community acceptance: Community acceptance would also be difficult because both the human health and the environment risks are not addressed by this alternative.

4.4.3.2 S2/S6/S7: Excavation, Capping and Biotreatment followed by Solidification/Stabilization (Pump Station - Sediments). Biological treatment followed by solidification/stabilization is a treatment alternative effective in treating organic contaminants by biological treatment followed by residual metals management. The process begins with conventional biological treatment. Soils or sediments are excavated and placed in a controlled treatment unit. The soil is aerated either mechanically by tilling or passively by drawing air through vent pipes placed in soil piles. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade a wide range of organics including TPH. Nutrients or special microorganisms can also be added to enhance the remediation process.

Upon completion of the bioremediation, solidification additives are mixed with the soil still contaminated with residual metals. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, analytical and physical characterization must be performed to ensure compatibility and

effectiveness. Following treatment, and after the solidified mixture has passed the Toxicity Characteristic Leaching Procedure TCLP test, it can be returned to the excavation on site. A process flow diagram is shown in Appendix E.

Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils and nutrients as needed
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Application of solidification agents
- TCLP metals analysis
- Apply cover material if needed to comply with SFRWQCB requirements, and
- Regrade site

Protection of human health and the environment: Biodegradation followed by solidification/stabilization would be effective in protecting human health and the environment against TPH and heavy metals. However, bioremediation has not demonstrated its effectiveness in degrading DDD or DDT on a commercial scale (EPA 1988). Although DDD exceeds the PRG (2.67 mg/kg), the risk associated with DDD is very small and remediation is not necessary for the protection of human health. Both DDD and DDT were identified in the ecological risk. Pesticides may be treated by solidification/stabilization, but a treatability test would be needed to confirm.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater and the preliminary remediation goal for DDD is 2.67 mg/kg. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH remedial action objective may be attained. A pilot study is recommended to determine degradation rates. Bioremediation may not be effective in reducing DDD or DDT concentrations. Solidification/stabilization may be effective in immobilizing both pesticides based on bench scale tests of similar compounds (EPA 1990c). A treatability test would be needed to confirm treatment effectiveness. An alternative treatment might be used if necessary to treat DDD and DDT contaminated sediment. Bioremediation/solidification could be used to treat sediments that do not have DDD or DDT. Solidification/stabilization would fulfill lead, beryllium, copper and other metal requirements.

All action-specific ARARs that apply to excavation, biotreatment and solidification/stabilization would be met with proper technology implementation. Action-specific ARARs include excavation, stockpiling, air emissions, land treatment, and applying cover material. These requirements may require compliance to RCRA waste levels if the sediment is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). Additionally, if the sediment is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Bioremediation followed by solidification/stabilization would be protective in the long-term because TPH would be removed in the sediment and the heavy metals would be immobilized. However, bioremediation has not demonstrated its effectiveness in degrading DDD or DDT on a commercial scale (EPA 1988). Although DDD exceeds the PRG (2.67 mg/kg), the risk associated with DDD is very small and remediation is not necessary for the protection of human health. DDD and DDT were identified as ecological risk (Engineering-Science 1993). The stabilization process may be effective for DDD and DDT but this would need to be confirmed by a treatability test.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation followed by solidification/stabilization would reduce the toxicity, mobility, and volume of TPH, metals, and DDD/DDT.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, which could be minimized with engineering controls and personal protection equipment. There is minimal risk to the public during remediation. Cleanup time is expected to be approximately two years.

Implementability: Bioremediation followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.3.2 in Appendix D. Remediation of sediments contaminated with TPH and metals involves excavating and treating 460 cubic yards of sediment (southern half) and applying 3 feet of cover material over the area. Capital costs are estimated to be $102,000 and annual costs are estimated to be $35,000 per year. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is estimated to be $162,000, assuming a 2-year project life and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH and metals. Another technology could be selected for treating sediments contaminated with DDD or DDT.

Community acceptance: Community acceptance may be difficult because DDD exceeds the PRG even though the human health risk associated with DDD is very small. The effectiveness of the DDD and DDT to biodegradation and/or solidification/stabilization is not known. Another technology could be selected for treating soils contaminated with DDD or DDT.

4.4.3.3 S2/S8/S7: Excavation, Capping and Low Temperature Thermal Desorption followed by Solidification/Stabilization (Pump Station - Sediments). Low temperature thermal desorption followed by solidification/stabilization is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Solidification additives are then mixed with the treated soils from the thermal desorption unit. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

Low temperature thermal desorption would be successful in removing the TPH and other contamination. However, low temperature thermal desorption has not been proven on a commercial scale for the removal of DDD or DDT. Both have very low volatility and are not likely to be treated effectively by low temperature thermal desorption. It may be possible to treat DDD/DDT by the solidification/stabilization process. A treatability test is needed to confirm treatment effectiveness. Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites for similar applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches

- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Application of solidification agents
- TCLP metals analysis
- Apply additional cover material if needed to comply with SFRWQCB requirements
- Regrade site
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: Low temperature thermal desorption followed by solidification/stabilization would be effective in protecting human health and the environment against TPH and heavy metals. The technology's effectiveness in reducing the risk posed from the DDD/DDT cannot be explicitly evaluated because the technology's effectiveness has not been proven on a commercial scale at other CERCLA sites. A treatability study would need to be conducted if this alternative is selected. However, the human health risk to the site related to DDD is very small and remediation of DDD is not necessary for the protection of human health. DDD and DDT were identified as chemicals of concern based on the ecological risk assessment in the EI. A treatability test is needed to confirm if solidification/stabilization is effective in treating DDD and DDT.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection for the underlying groundwater. Preliminary remediation goals (PRGs) have been calculated for analytes where EPA carcinogenic data is available. DDD exceeds its PRG of 2.67 mg/kg. Based on DTSC guidance, the cleanup level for inorganic lead is 535 mg/kg, which requires treatment if concentrations exceed this limit. Beryllium exceeds PRG and background levels at four sample areas. Although copper does not exceed PRGs, the carcinogenic risk from ingestion exceeds 1 x 10^{-6}. One copper sample exceeded background at PS-SD-6. Other metals and DDD/DDT were identified in the ecological risk assessment as chemicals of concern.

Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm. Solidification/stabilization has demonstrated effectiveness in managing heavy metals. Solidification/stabilization may be effective in immobilizing DDD and DDT, however, a treatability study is needed to confirm this.

With proper technology implementation, action-specific ARARs that apply to low temperature thermal desorption followed by solidification/stabilization would be met. Action-specific ARARs include excavation, stockpiling, air emissions, and applying cover material. These ARARs may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic of a

hazardous waste. Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption followed by solidification/stabilization would be protective in the long-term because TPH would be removed and the heavy metals would be stabilized. Solidification/stabilization may be effective in treating low concentrations of DDD and DDT. However, it has not been proven to be successful on a commercial scale. A treatability study would need to be conducted to determine the long-term effectiveness. The risk to the site attributed to the presence of DDD is very small and the remediation of DDD is not necessary for the protection of human health.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption followed by solidification/stabilization would reduce the toxicity, mobility, and volume of TPH, DDD and heavy metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, which may be minimized with engineering controls and personal protection equipment. Air emissions must be monitored and controlled. Remediation period is expected to be one year.

Implementability: Low temperature thermal desorption followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes. DDD and DDT are a highly chlorinated aromatic compounds and the air board would likely be very reluctant to permit thermal desorption of soils contaminated with halogenated compounds.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.3.3 in Appendix D. Remediation of soils contaminated with TPH and metals involves excavating and treating 460 cubic yards of sediment (southern half) and applying 3 feet of cover material over the area. Capital costs are estimated to be $212,000 the project is estimated to take 6 months. It is assumed that groundwater monitoring would continue for 20 years, and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance is not likely for soils contaminated with DDD or DDT. State agencies may accept thermal desorption for those soils that are not contaminated with chlorinated compounds provided an alternate treatment is selected for DDD and DDT contamination.

Community acceptance: Community acceptance may be difficult because of perception regarding thermal treatment processes in their communities.

4.4.3.4 S2/S9/S7: Excavation, Capping and Off-site Thermal Destruction followed by Solidification/ Stabilization (Pump Station - Sediment). This alternative is initiated with conventional excavation of the contaminated sediment followed by off-site transportation which may be completed by truck or rail. Treatment of contaminated soil involves incineration at high temperature (>2000° F) to destroy and remove contaminants. The treatment facility is responsible for and will certify the destruction of the waste, treatment of the off-gas, and final disposal of incinerator residuals (ash). A process flow diagram is shown in Appendix E.

Disposal of the incineration ash would require solidification if heavy metal concentrations exceed action-specific ARARs requiring treatment of the residual ash prior to land disposal with solidification/stabilization. The process involves the addition of solidification additives mixed with the residual ash. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation site.

A significant portion of the cost for off-site incineration is transportation, because California does not have a commercial incineration facility. For costing purposes, the Rollins Facility in Deer Park, Texas was selected as the designated incineration facility.

The sequence of activities that would be performed in this alternative consist of the following:

- Excavation of contaminated soils
- Transportation of contaminated soils to off-site incineration facility
- Incineration
- Application of solidification agents to residual ash
- TCLP metals analysis
- Disposal of solidified ash
- Apply cover material if needed to comply with SFRWQCB requirements, and
- Regrade site

Protection of human health and the environment: This alternative provides protection for human health and the environment by providing a proven remedy that destroys the organic contaminants present and successfully manages the remaining inorganics, providing a long-term permanent solution.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Beryllium exceeds PRG and background levels. Although copper does not exceed PRGs, the carcinogenic risk from ingestion exceeds 1×10^{-6} and one copper sample exceeded background. Preliminary remediation goals have been calculated for these analytes where risk

information is available. DDD exceeds its PRG of 2.67 mg/kg. Based DTSC guidance, the maximum inorganic lead concentration that can be left in place is 535 mg/kg. Off-site incineration is proven to be an effective treatment for the remediation of organic contamination in soil. Solidification/stabilization has demonstrated effectiveness in managing heavy metals.

Action-specific ARARs that apply to off-site incineration followed by solidification/stabilization include excavation, air emissions, and Department of Transportation requirements. Additionally, the designated incineration facility will be responsible for fulfilling action-specific ARARs that apply to their process. These ARARs include incineration ARARs as presented in Appendix F, Table F-2, which would be applicable if the waste is determined to be a RCRA hazardous waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). All action-specific ARARs may be met with proper technology implementation.

This alternative is consistent with location-specific ARARs for wetlands, critical habitats and endangered species protection. The ecological risk assessment identified DDD, DDT and additional metal contaminants of concern which will be effectively treated by this alternative.

Long-term effectiveness and permanence: This alternative would result in complete destruction of TPH, DDD and DDT contamination. The heavy metals contamination would be effectively managed by solidification/stabilization.

Reduction of toxicity, mobility, or volume through treatment: Off-site incineration would be effective in reducing the toxicity, mobility, or volume of the organic contaminants. The mobility of the heavy metal contamination would be reduced by solidification/stabilization.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation and material handling. However, with engineering controls and personal protection equipment the technology can be implemented effectively. The off-site facility should meet RCRA requirement and be protective of the community.

Implementability: Off-site incineration followed by solidification/stabilization may be readily implemented as it is a proven technology, and it can be reliably operated. However, RCRA facility capacity may be limiting.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.3.4 in Appendix D. Remediation of sediments contaminated with TPH, pesticides and metals involves excavating and treating 22,220 cubic yards of sediment (entire site) and applying 3 feet of cover material over the excavated area. Capital costs are estimated to be $54,105,000. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable because this alternative would result in complete destruction of organic contaminants and management of the inorganics by controlling their mobility. However, the State favors on site treatment and disposal if possible.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk. The community, however, would prefer to avoid transporting hazardous materials and to treat the sediment on site if possible.

4.4.3.5 S2/S11/S7: Excavation, Capping and Chemical Oxidation followed by Solidification/Stabilization (Pump Station - Sediment). Chemical oxidation processes are an effective remedial alternative for the treatment of organic contaminants by transforming contaminants into less toxic substances. Oxidizing agents such as ozone and hydrogen peroxide are added to the sediment to facilitate organic contaminant degradation. The oxidizing agents attack carbon-carbon bonds oxidizing the organic species to carbon dioxide and water. In the process, the sediments would be mixed with the oxidizing agent and placed into a controlled treatment unit for continued contaminant degradation. A process flow diagram is shown in Appendix E. Solidification/ stabilization is a demonstrated technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of sediment storage pads and processing system
- Convey soils to processing system for application of oxidizing agents
- Placement of sediments into treatment unit
- Sample treated sediments to monitor contaminant removal
- Application of solidification agents
- TCLP metal analysis
- Apply cover material if needed to comply with SFRWQCB requirements, and
- Regrade site

Protection of human health and the environment: The risk to the environment, and the risk resulting from migration of TPHs and metals to groundwater would be reduced. DDT and DDD would degrade to DDE as an intermediate reaction product which is also toxic. Continued treatment by chemical oxidation could ultimately produce innocuous end products and acid. The acid can be neutralized by conventional techniques. A treatability test is needed to confirm whether chemical oxidation is effective for DDD and DDT.

Compliance with ARARs: A remedial action objective for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Chemical oxidation has been proven to be an effective treatment for the remediation of TPH contamination in

soil. However, chemical oxidation may not be effective in reducing TPH concentrations down to 10 mg/kg as indicated by results of remediation efforts at the POL Area (International Technology, 1991). A treatability study would be needed to confirm effectiveness in treating TPH. The efficiency of chemical oxidation in treating DDD and DDT is not known and a treatability study should be expanded to consider treatment effectiveness on pesticides. Solidification/stabilization would reduce the mobility and impact of lead, copper, beryllium and other contaminants of concern on the environment.

With proper technology implementation, action specific ARARs that apply to excavation and chemical oxidation would be met. Action specific ARARs include excavation, stockpiling, air emissions, applying cover material and possible treatment of spent oxidizing solution. These requirements may require compliance to RCRA waste levels if the sediment is determined to be a RCRA waste. For the sediment to be classified as a RCRA waste, the sediment contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the sediment is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Chemical oxidation would be protective in the long-term because most of the TPH contamination would be transformed into less toxic substances in the sediment. The efficiency of chemical oxidation in treating DDD/DDT is not known and a treatability study is needed. Solidification/stabilization would reduce the mobility and impact of lead, beryllium and other contaminants of concern on the environment.

Reduction of toxicity, mobility, or volume through treatment: Chemical oxidation would reduce the toxicity, mobility, and volume of the TPH and metal contamination. Chemical oxidation could create toxic intermediate products. Additional tests to confirm complete destruction of DDT, DDD and intermediate products would be needed.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. The risk to the community is minimal during remediation since contaminants will be destroyed. Remediation period is approximately one year.

Implementability: Chemical oxidation and solidification/stabilization technologies may be readily implemented since, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.3.5 in Appendix D. Remediation of sediments contaminated with TPH, pesticides and metals involves excavating and treating 22,220 cubic yards of sediment (entire site) and applying 3 feet of cover material over the excavated area. Capital costs

are estimated to be $6,102,000 and the project is estimated to take one year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: If treatability test results are favorable regulatory acceptance should be attainable. Additional sampling is needed to insure that intermediate products are also remediated during treatment.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.4.3.6 S2/S12: Excavation, Capping and Soil Washing (Pump Station-Sediment). Direct soil washing is a chemical/physical treatment method for organic and heavy metal contaminated soils. It extracts contaminants from soil and sediment with washing solution such as water, organic solvents, surfactants, acids, or bases. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After treatment, the detoxified soil can be returned to the excavation as fill material. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 0.25 inches from soil
- Shred material larger than 0.25 inches
- Convey soils to processing system
- Treat soils with washing solution
- Dewater treated soils
- Sample treated soil to monitor contaminant removal
- Treatment of waste water (washing solution)
- Apply cover material if needed to comply with SFRWQCB requirements, and
- Regrade site

Protection of human health and the environment; Soil washing is an effective technology for the treatment of DDT, DDD, DDE, and some heavy metals in soils. Contaminants are transferred to a solvent medium which then requires treatment.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established for the protection of groundwater. Other chemicals of concern include pesticides and heavy metals. Washing additives would be selected that would remediate

chemicals of concern. Sequential washing steps may be needed in order to comply with chemical specific ARARs. A treatability study should be conducted to determine the effectiveness of this technology.

All the action specific ARARs that apply to excavation and soil washing would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, applying cover material and possibly treatment of washwater prior to discharge. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the sediment is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during design phase of this alternative.

Long-term effectiveness and permanence: Soil washing may be protective in the long-term because the heavy metals and organics would be removed from the sediment, thus preventing direct contact with the contaminated sediment, and minimizing potential leaching of the residual contaminants. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern. Contaminants would be transferred to a solvent medium which would then require treatment.

Reduction of toxicity, mobility, or volume through treatment: Soil washing may reduce the toxicity, mobility, and volume of the heavy metals and small amounts of organics at the site. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however, engineering controls and personal protection equipment can minimize exposure. The process would remove contaminants from the soil.

Implementability: Soil washing may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-4.3.6 in Appendix D. Remediation of sediments contaminated with TPH, pesticides and metals involves excavating and treating 22,200 cubic yards of sediment (entire site) and applying 3 feet of cover material over the excavated area. Capital costs are estimated to $5,675,000 and the project is estimated to take six months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable since this technology has been effective (on a pilot scale) in removing the chemical of concern from the sediment.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the environment should be favorable if the technology is proven effective.

4.5 SITE 5: FORMER SEWAGE TREATMENT PLANT

The Former Sewage Treatment Plant (FSTP) was in operation until 1986 when buildings associated with the plant were demolished, and sludge drying beds and storage tanks were removed. Results of the EI found low levels of organics in the upper few feet of soil and sediment at the FSTP (Engineering-Science 1993). Metal concentrations were detected relatively uniformly from the surface to a depth of 9.5 feet in the soil (TP-MW-101), however, only beryllium and arsenic exceeded PRGs. Both metals are within background. PCB was detected in sludge drying beds (TP-SS-1, 6, 7 and 8), at levels which exceed the PRG (0.08 mg/kg).

Two additional analytes were identified by the human health carcinogenic risk assessment: aldrin and DDD. Aldrin was detected at two sites, TP-SS-1 and TP-SS-8 at 0.02 and 0.03 mg/kg respectively. DDD was detected in all nine samples at sites TP-SS-1 through TP-SS-8 inclusive. DDD concentrations ranged from 0.005 mg/kg to 0.73 mg/kg and at TP-SS-3 the DDD concentration was 1.39 mg/kg, none of which exceed the PRG of 2.67 mg/kg. The estimated volume of soil contaminated with TPH, PCB or DDD at the sludge drying bed is 1,200 cubic yards. The area of contamination is shown by the cross hatch lines in Figure 1.7.

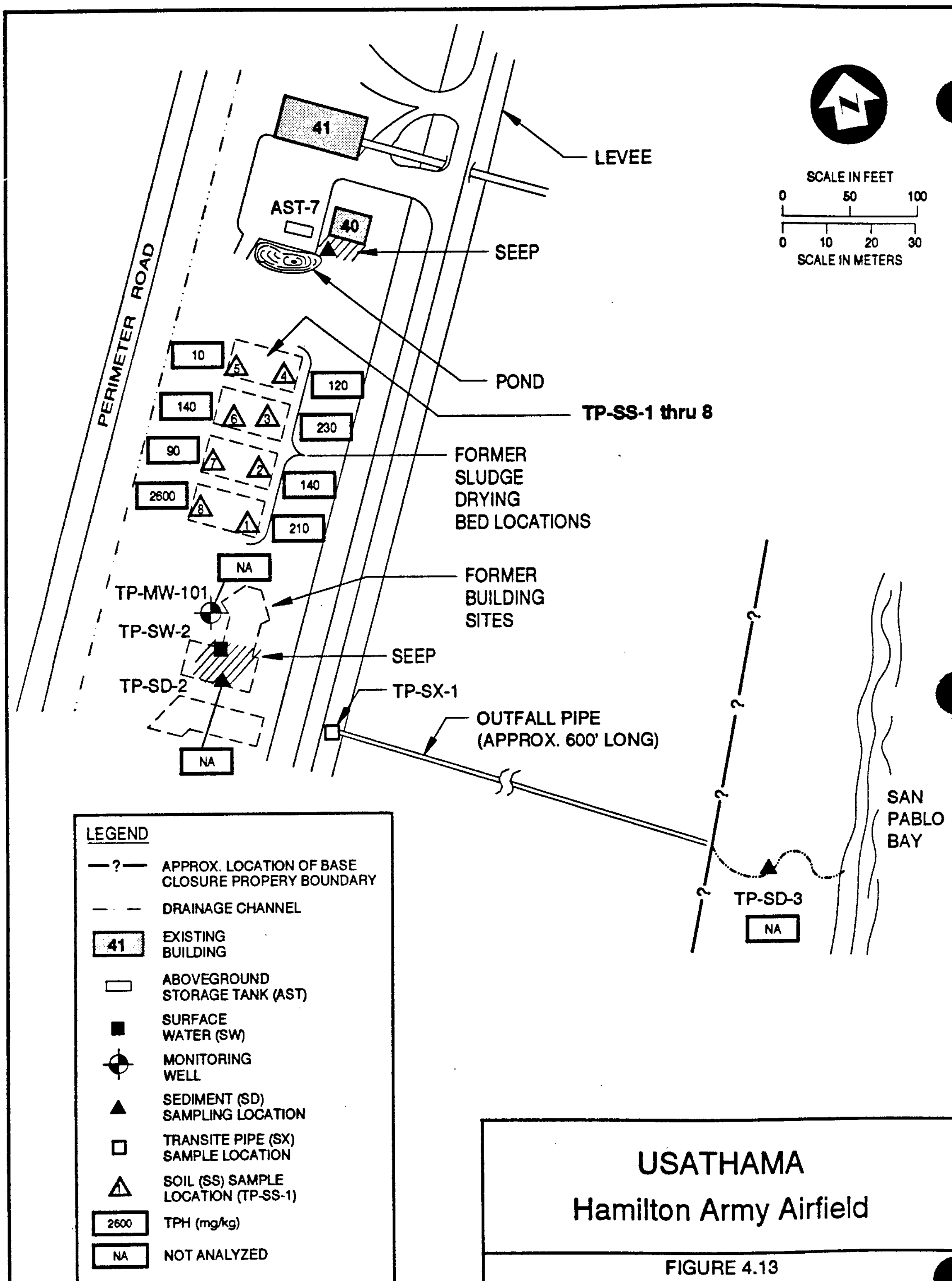
The hazard index for non-carcinogenic risks exceeds one requiring remediation of additional analytes including chromium in soil and sediments, and vanadium in sediments. Chromium in the sediment and soil and vanadium in the sediment were within background levels.

Additional analytes identified by the ecological risk assessment which require remediation for the protection of the environment include mercury, DDT, DDD (additional samples) and DDE in the soil. Mercury was detected at TP-SD-2 but at levels that are within background concentrations. The pesticides were detected throughout the former sludge drying beds in samples TP-SS-1 through TP-SS-8. Mercury exceeded background at PS-SS-1, 2, 3, 6 and 8. Nickel exceeded the SFRWQCB screening criteria (90 mg/kg) at TP-SD-3. The tidal marsh where TP-SD-3 was sampled is part of Operable Unit 2. Except for the tidal marsh, the FSTP is part of Operable Unit 1.

Figure 4.13 and Figure 4.14 are area maps which show the concentrations of TPH and PCB at the site.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S9/S7: Excavation and Thermal Destruction followed by Solidification/ Stabilization;
- S11/S7: Excavation and Chemical Oxidation followed by Solidification/ Stabilization; and
- S12: Excavation and Soil Washing.



USATHAMA

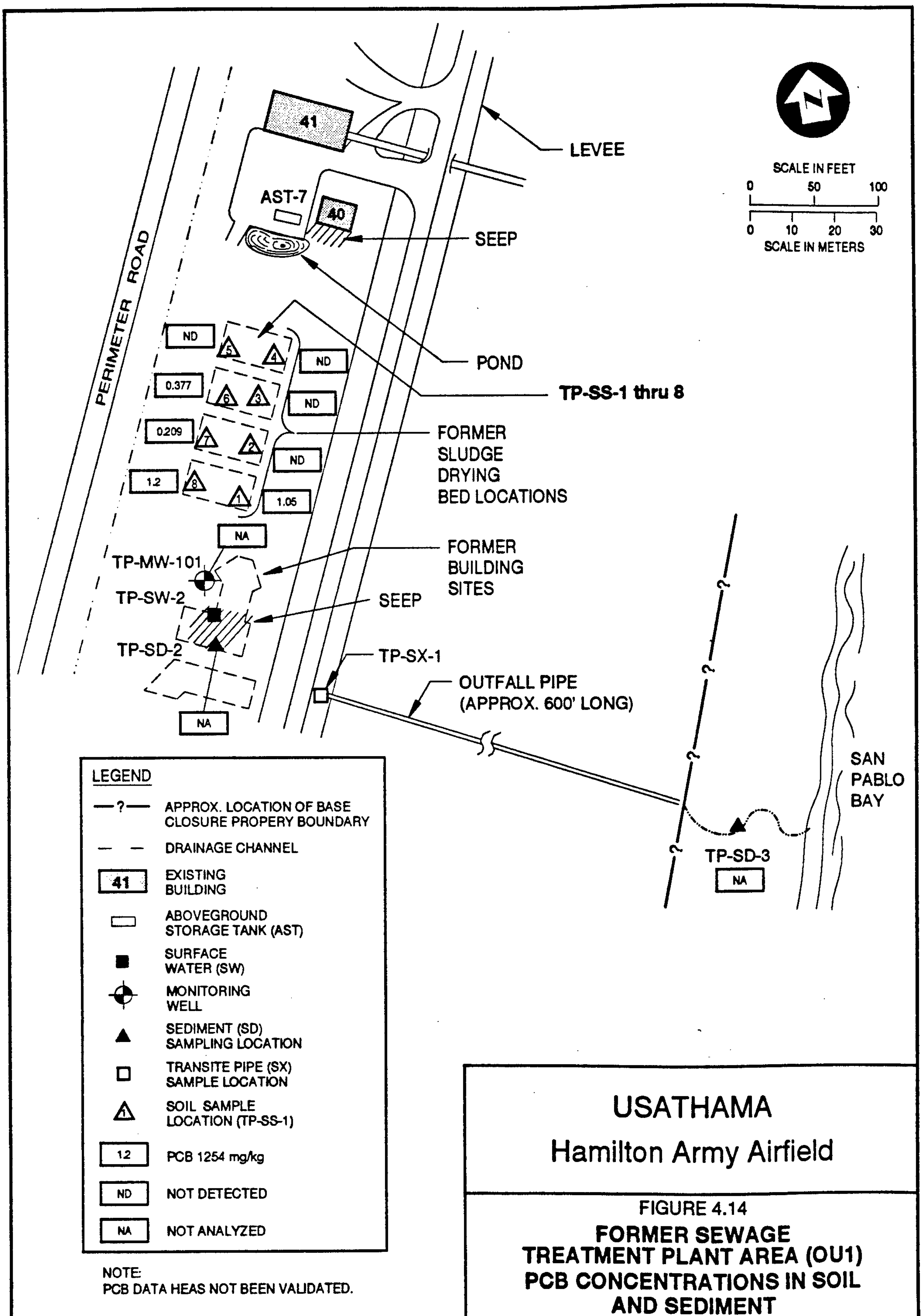
Hamilton Army Airfield

FIGURE 4.13

FORMER SEWAGE TREATMENT PLANT AREA (OU1) TPH CONCENTRATIONS IN SOIL AND SEDIMENT

REV. 3 C335-19.DWG 04/26/96

ENGINEERING-SCIENCE, INC.



USATHAMA

Hamilton Army Airfield

FIGURE 4.14

FORMER SEWAGE TREATMENT PLANT AREA (OU1) PCB CONCENTRATIONS IN SOIL AND SEDIMENT

REV. 3 C335-18.DWG 04/26/94

ENGINEERING-SCIENCE, INC.

The following sections present the evaluation for the alternatives relative to the evaluation criteria. Additionally, Figure 4.15 presents the summary of the detailed analysis of the remedial alternatives retained relative to the evaluation criteria. This figure is subdivided by types of contaminants. Certain alternatives are more applicable to specific types of contaminants and costs have been estimated assuming a given chemistry and volume for similar contamination. At least one alternative from each category needs to be selected and combined with the other selected alternatives for a final remedy.

4.5.1 S1: No Action (FSTP)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil and sediment at this site would consist of no remedial activities. The soil would remain in place. Contaminated soil left in place would include soils with TPH concentration greater than 10 mg/kg and pesticides exceeding PRGs. Risks associated with manganese, and mercury may require long-term groundwater monitoring. Land use restrictions are necessary to warn and limit receptor access to the site because there is an expected risk to human health and the environment (Engineering-Science 1993).

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to human health and the environment would not change. This alternative does not fulfill the intent of the CERCLA/SARA by providing permanent protection of human health and the environment. The only protection provided by this alternative is by implementing land use restrictions.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of underlying groundwater. Other chemicals of concern include PCBs, pesticides and heavy metals. The no action alternative will not comply with cleanup criteria or PRGs. There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs are not satisfied because there is a moderate expected risk for the present and short-term wetlands land options to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative would not be directly effective in reducing residual contamination. TPH would naturally degrade over time but pesticides, PCB, and heavy metals will likely persist.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-term effectiveness: With the no action alternative, there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative. However, contaminants have the potential to mitigate to groundwater.

FIGURE 4.15

Evaluation of Soil Remedial Alternatives

Site 5: Former Sewage Treatment Plant

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	○	○	○	○	◕	◕	○	○	529,000
PCB, TPH Pesticides and Metals	S9/S7: Excavation & Thermal Destruction Solidification/ Stabilization	●	●	●	●	◕	◕	◕	◕	2,696,000
	S11/S7: Excavation & Chemical Oxidation Solidification/ Stabilization (d)	◔	◔	◔	◑	◑	◑	◑	◑	362,000
	S12: Excavation & Soil Washing (d)	◑	◑	◑	◑	◑	◑	◕	◕	403,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for the Area near TP-SD-1 which is only Contaminated with Metals. The Remaining Alternatives Address the PCB, DDT, DDD, DDE, Aldrin and Metals Contamination

Implementability: This alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to state and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-5.1 Capital costs of $38,000 are associated with installation of wells, and implementing site restrictions. Annual costs of approximately $52,000 are associated with installation of two new wells and monitoring, which account for present work costs of $529,000 assuming 30 years of operation and a 10 percent annual interest rate. A variation of the no action alternative assumes quarterly groundwater monitoring for only one year. The cost for this alternative is $40,800 and is discussed in Section 5.

State acceptance: Regulatory acceptance may be difficult to attain because this alternative will not comply with cleanup criteria on PRGs.

Community acceptance: Community acceptance would also be difficult to attain due to public perceptions regarding land use and lack of active treatment of contaminants.

4.5.2 S9/S7: Excavation and Off-site Thermal Destruction followed by Solidification/Stabilization (FSTP)

This alternative is involves excavation of the contaminated soil followed by off-site transportation which may be completed by truck or rail. Treatment of contaminated soil involves incineration at high temperature (>2000° F) to destroy the contaminants. The treatment facility is responsible for and will certify the destruction of the waste, treatment of the off-gas, and final disposal of incinerator residuals (ash). A process flow diagram is shown in Appendix E.

Disposal of the incineration ash would require solidification if heavy metal concentrations exceed action specific ARARs requiring treatment of the residual ash prior to land disposal with solidification/stabilization. The process involves the addition of solidification additives mixed with the residual ash. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

A significant portion of the cost for off-site incineration is transportation, because California does not have a commercial incineration facility. For costing purposes, the Rollins Facility in Deer Park, Texas was selected as the designated incineration facility.

This alternative is being considered for treating the soils in the former sludge drying beds. The sequence of activities that would be performed in this alternative consist of the following:

- Excavation of contaminated soils
- Transportation of contaminated soils to off-site incineration facility
- Incineration

- Application of solidification agents to residual ash
- TCLP metals analysis
- Disposal of solidified ash
- Backfill and compaction of the excavation, and
- Regrade site

Protection of human health and the environment: This alternative provides protection for human health and the environment by providing a proven remedy that destroys the organic contaminants present and successfully manages the remaining inorganics, providing a long-term permanent solution.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. PCB exceeds its PRG. Pesticides detected throughout the former sludge treatment beds require treatment based on the ecological risk assessment. Mercury was detected in the soil samples above background levels which also poses an ecological risk and requires remediation. Off-site incineration is proven to be an effective treatment for the remediation of organic contamination in soil. Solidification/stabilization has demonstrated effectiveness in managing heavy metals.

Action specific ARARs that apply to off-site incineration followed by solidification/stabilization include excavation, air emissions, and Department of Transportation requirements. Additionally, the designated incineration facility will be responsible for fulfilling action specific ARARs that apply to their process. These include incineration ARARs as presented in Appendix B.2, Table B-2. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA hazardous waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: This alternative would result in complete destruction of pesticide, PCB and TPH contamination. The heavy metals contamination would be effectively managed by solidification/stabilization.

Reduction of toxicity, mobility, or volume through treatment: Off-site incineration would be effective in reducing the toxicity, mobility, or volume of the organic contaminants. The mobility of the heavy metal contamination would be reduced by solidification/stabilization.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation and material handling. However, with engineering

controls and personal protection equipment the technology can be implemented effectively. Incineration would destroy organic contaminants and metal would be immobilized by solidification.

Implementability: Off-site incineration may be readily implemented as it is a proven technology, and it can be reliably operated. However, RCRA facility capacity may be limiting.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-5.2 in Appendix D. Remediation of soil contaminated with pesticides, PCB, TPH and mercury involves excavating and treating 1,200 cubic yards of soil at and near the former sludge drying beds. Capital costs are estimated to be $2,696,000. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable because this alternative would result in complete destruction of organic contaminants and management of the inorganics by controlling their mobility. However, the State would prefer on site treatment and disposal if possible.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk. However, the community would prefer not to transport hazardous materials and would prefer to treat the soil on site if possible.

4.5.3 S11/S7: Excavation and Chemical Oxidation Followed by Solidification/Stabilization (FSTP)

Chemical oxidation processes are an effective remedial alternative for the treatment of organic contaminants by transforming contaminants into less toxic substances. Oxidizing agents such as ozone and hydrogen peroxide are added to soil to facilitate organic contaminant degradation. The oxidizing agents attack carbon-carbon bonds oxidizing the organic species to carbon dioxide and water. In the process, soils would be mixed with the oxidizing agent and placed into a controlled treatment unit for continued contaminant degradation. A process flow diagram is shown in Appendix E.

The solidification/stabilization treatment technology is typically used to immobilize heavy metal contamination. The technology uses solidification additives to immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. The process begins by conventionally excavating the contaminated soil and mixing the soil with the selected solidifying agent. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After the solidified mixture has passed the TCLP test, it can be returned to the excavation as fill material.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of soil storage pads and processing system

- Convey soils to processing system for application of oxidizing agents
- Placement of soils into treatment unit
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Sample treated (oxidized) soil to monitor contaminant removal
- Addition of solidification agents
- TCLP metal analysis
- Backfill and compaction of the excavation, and
- Regrade site

Protection of human health and the environment: The risk to the environment resulting from potential migration of pesticides, PCBs, metals, and TPHs to groundwater would be reduced because most of the contamination source would be transformed into less toxic substances or immobilized by solidification/stabilization additives. A treatability study is needed to confirm if chemical oxidation is effective for DDT and DDD.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Chemical oxidation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Pesticides and mercury detected throughout the former sludge treatment beds require treatment based on the ecological risk assessment. PCB exceeds it PRG. Chemical oxidation has not been proven in treating pesticides or in treating PCB in a clay-like soil. A treatability study would be needed to determine effectiveness in attaining ARARs. Solidification/stabilization could immobilize the metals.

With proper technology implementation, action specific ARARs that apply to excavation and chemical oxidation would be met. Action specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: TPH and some of the PCB contamination would be transformed into less toxic substances in the soil. However, the effectiveness of treatment on pesticides needs to be evaluated.

Reduction of toxicity, mobility, or volume through treatment: Chemical oxidation followed by solidification/stabilization would reduce the toxicity, mobility, and volume of the contaminants. However, a treatability test is needed to determine the effectiveness of chemical oxidation in treating pesticides and PCBs.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. A treatability study is needed to demonstrate chemical oxidation effectiveness in treating soils contaminated with PCBs and pesticides.

Implementability: Chemical oxidation requires a treatability study prior to implementation. The technology may be readily implemented as it is a proven technology and components are commercially available. Reliability during operations requires evaluation as part of the treatability study.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-5.3 in Appendix D. Remediation of soil contaminated with pesticides, PCB, TPH and mercury involves excavating and treating 1,200 cubic yards of soil at and near the former sludge drying beds. Capital costs are estimated to be $362,000 and the project will take less than one year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: A treatability study that demonstrates successful treatment of PCB and pesticide is needed in order to obtain regulatory acceptance.

Community acceptance: A treatability study that demonstrates successful treatment of PCB and pesticide is needed in order to obtain regulatory acceptance.

4.5.4 S12: Excavation and Soil Washing (FSTP)

Direct soil washing is a chemical/physical treatment method for organic and heavy metal contaminated soils. It extracts contaminants from soil and sediment with washing solution such as water, organic solvents, surfactants, acids, or bases. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After treatment, the detoxified soil can be returned to the excavation as fill material. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger the .25 inches from soil
- Shred material larger than .25 inches
- Convey soils to processing system

- Treat soils with washing solution
- Dewater treated soils
- Sample treated soil to monitor contaminant removal
- Treatment of waste water (washing solution)
- Backfill and compaction of the excavation
- Regrade site

Protection of human health and the environment; Soil washing is an effective technology for the treatment of PCB, DDT, DDD, DDE, and some heavy metals in soils. Contaminants are transferred to a solvent medium which then requires treatment.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established for the protection of groundwater. Other chemicals of concern include PCB, pesticides and heavy metals. Washing additives would be selected that would remediate chemicals of concern. Soil washing average efficiency for removing PCB is 71 percent based on EPA studies (EPA 1990c). This may not be sufficient for meeting ARARs. Sequential washing steps may be needed in order to comply with chemical specific ARARs. A treatability study is recommended.

All the action specific ARARs that apply to excavation and soil washing would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, compaction of soil and possibly treatment of washwater prior to discharge. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during design phase of this alternative.

Long-term effectiveness and permanence: Soil washing may be protective in the long-term because the heavy metals and organics would be removed from the soil, thus preventing direct contact with the contaminated soil, and minimizing potential leaching of the residual contaminants. A treatability study could be needed to determine the technologies effectiveness for the chemicals of concern. Contaminants would be transferred to a solvent which would then require treatment.

Reduction of toxicity, mobility, or volume through treatment: Soil washing may reduce the toxicity, mobility, and volume of the heavy metals and small amounts of organics at the site.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however, engineering

controls and personal protection equipment can minimize exposure. The process would remove contaminants from the soil.

Implementability: Soil washing may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-5.4 in Appendix D. Remediation of soil contaminated with pesticides, PCB, TPH and mercury involves excavating and treating 1,200 cubic yards of soil at and near the former sludge drying beds. Capital costs are estimated to be $403,000 and the project will last about six months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-4. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable since the effectiveness of this technology has demonstrated in removing the chemical of concern from the soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the environment should be favorable if the technology is proven effective.

4.6 SITE 6: EAST LEVEE LANDFILL

The East Levee landfill consists of a 2 to 6 feet thick layer of construction debris overlaid by a 0 to 2 feet thick cap of sandy clay with gravel and concrete. The area of contamination is shown in Figure 1.8. The estimated soil volume at the East Levee Landfill is 5,000 cubic yards. Previous investigations conducted in 1987 which included extensive trenching found low concentrations of TPHs, VOCs, SVOCs, and some metals present in shallow soils. TPH concentrations ranged from non-detect to 110 mg/kg in five sample locations (Woodward-Clyde 1987). The EI conducted in 1991 found no significant VOCs or SVOCs contamination, and no elevated concentrations of metals. TPH was not evaluated during the environmental site investigation (Engineering-Science 1993) but is assumed to still remain on site from the 1987 investigation.

Although results of the human health risk assessment indicate that beryllium and arsenic risks exceed an acceptable level of carcinogenic risk, neither metal exceeded background concentrations. Contaminants found at the East Levee Landfill present no environmental risk under present use scenarios (Engineering-Science 1993).

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S6: Excavation and Biotreatment;
- S8: Excavation and Low Temperature Thermal Desorption

The following section presents the evaluation for the no action alternative relative to the evaluation criteria. Additionally, Figure 4.16 presents the summary of the detailed analysis relative to the evaluation criteria.

4.6.1 S1: No Action (East Levee Landfill)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. Land use restriction may not be necessary because all analytes identified in the risk assessment are within background.

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to human health and the environment would not change. This alternative is protective of human health and the environment since all analytes identified by the risk assessment are within background.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. No other analytes exceed their PRG or cleanup level. There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state

FIGURE 4.16

Evaluation of Soil Remedial Alternatives

Site 6: East Levee Landfill

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	Moderate	Partial	Moderate	No	Moderate	Moderate	High	High	515,000
	S6: Excavation and Biological Treatment (d)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	395,000
	S8: Excavation & Thermal Desorption (d)	Moderate	Moderate	Moderate	Moderate	Partial	Moderate	Moderate	Partial	1,034,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs are not satisfied because there is a low expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative is not directly effective in reducing residual TPH contamination. The TPH contamination may naturally degrade over time.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative.

Implementability: This alternative is readily implemented technically, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-6.1. Capital costs of $17,000 are associated with monitoring the existing wells and implementing site restrictions. Annual costs of approximately $53,000 are associated with monitoring and maintenance, which account for present work costs of $515,000 assuming 30 years of operation and a 10 percent annual interest rate.

The regulatory agencies recognize that the extent of TPH contamination at the East Levee Landfill is small and relatively low. It may be possible to reduce the number of years required for groundwater monitoring. Agencies may consider eliminating the monitoring requirement if successive monitoring events show no contamination is present. For example, if only one year of monitoring is required, the cost would be $17,000 plus the cost to decommission the wells ($7,000). A variation of the no action alternative assumes no groundwater monitoring. The cost for this alternative is $7,500 and is explained in Section 5.

State acceptance: Regulatory acceptance has been given because four quarterly groundwater events indicate no groundwater contamination and the levels of TPH are sporadic and relatively low.

Community acceptance: Community acceptance is likely.

4.6.2 S6: Excavation and Biological Treatment (East Levee Landfill)

Biological treatment of contaminated soil has been proven effective for degrading TPH. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit and either tilling the soil or drawing air through to aerate. Nutrients or microorganisms could be added to enhance degradation. Typically degradation is assumed to take 6 to 18 months. A process flow diagram is shown in Appendix E.

Biodegradation would be successful in degrading the TPH contamination.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit (possibly including vent pipes and blowers)
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Till soils or drawing air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- TCLP metals analysis
- Backfill and compaction of the excavation, and
- Regrade site

Protection of human health and the environment: Biodegradation should be effective in protecting human health and the environment because it is a demonstrated effective technology for degrading the chemicals of concern at this site.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH remedial action objective may be attained.

All the action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Based on the analytical results for lead and other metals the soil will likely meet TCLP criteria without special treatment.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during design phase of this alternative.

Long-term effectiveness and permanence: Bioremediation appears to be protective in the long-term due to the technology's effectiveness in degrading the chemicals of concern.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the toxicity and volume of the organic contaminants.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however engineering controls and personal protection equipment would reduce exposure. Organic contaminants would be removed so that potential groundwater would be protected.

Implementability: Bioremediation may be readily implemented it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-6.2 in Appendix D. Capital costs are estimated to be $232,000 and are estimated to be $94,000 per year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-6. The present worth cost is estimated to be $395,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to the technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.6.3 S8: Excavation and Low Temperature Thermal Desorption (East Levee Landfill).

Low temperature thermal desorption followed by solidification/stabilization is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Low temperature thermal desorption would be successful in stripping the TPH contamination. The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal

- TCLP metals analysis
- Backfill and compaction of the excavation
- Regrade site, and
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: Low temperature thermal desorption should be effective in protecting human health and the environment because it is a demonstrated, effective technology for removing the chemicals of concern at this site.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption appears to be protective in the long-term due to the technology's effectiveness in removing the chemicals of concern.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the toxicity and volume of the organic contaminants.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Contaminant source would be removed and groundwater is protected. Remediation time is expected to be one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is proven technology, components are commercially available, and it can be reliably

operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-6.3 in Appendix D. Capital costs are estimated to be $1,034,000 and the project will take about four months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-6. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable since this is a proven technology in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be difficult because public perceptions regarding thermal treatment processes in their communities may not be favorable.

4.7 SITE 7: AIRCRAFT MAINTENANCE AND STORAGE

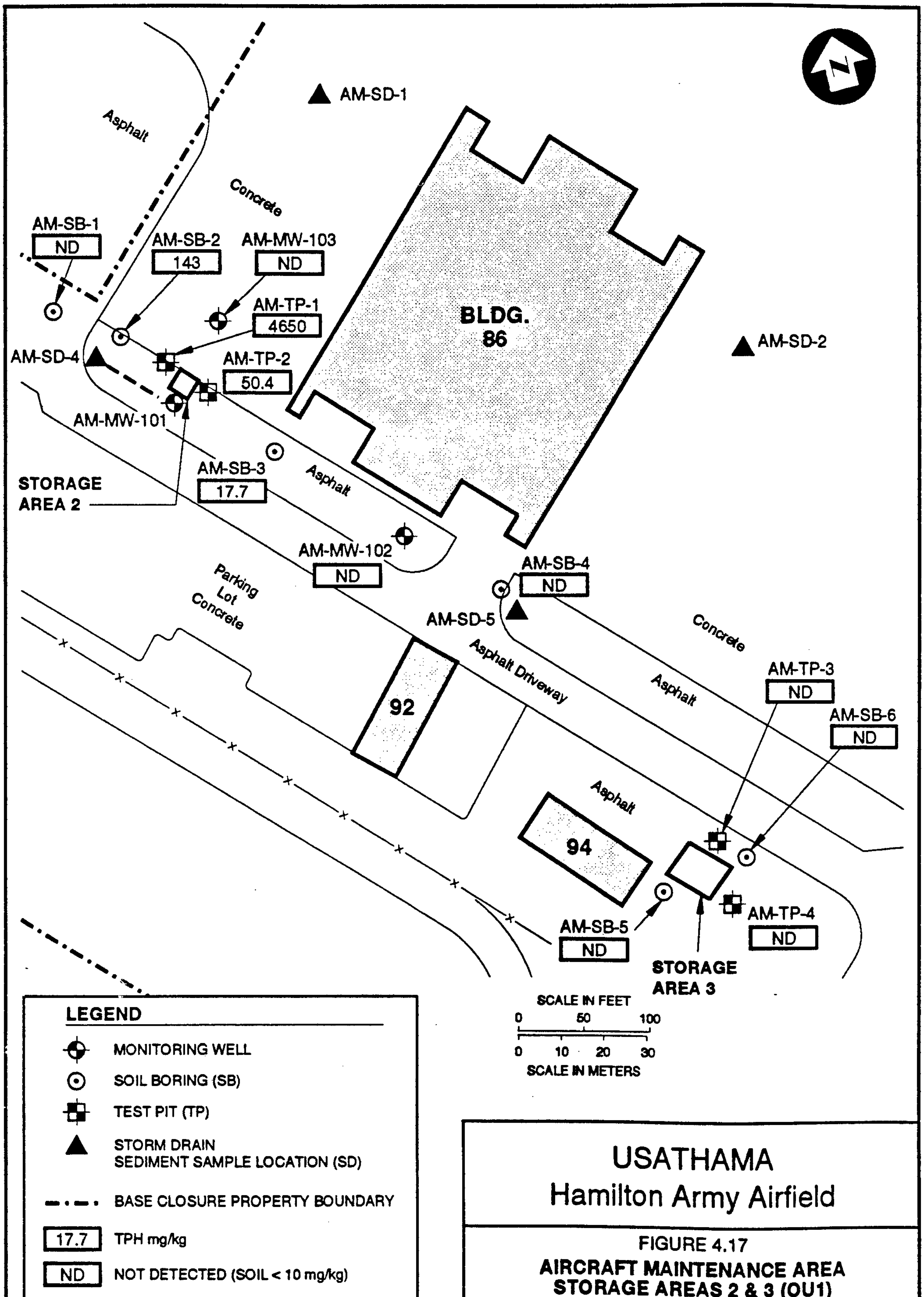
Several buildings including an aircraft hanger still in use (Bldg. 86) are located in the aircraft maintenance site. A gravelly backfill material up to 4 feet thick exists throughout the site. Portions of the fill are overlaid with dirt and vegetation, however, most of the site is capped by either asphalt (roads) or concrete (walkways, buildings, and the runway). There are concrete vaults that are interconnected throughout the site for storm water collection. Sediments that have collected at the base of these vaults are different in composition than the soils. Remedial action alternatives will be evaluated separately for the soils in the area and for the sediments.

4.7.1 Soil Contamination

Shallow soils within the Aircraft Maintenance and Storage Area were found to contain elevated levels of TPH reported as high as 4,650 mg/kg. These contaminants concentrations came from the same test pit, AM-TP-1 and decreased to 167 mg/kg and 125 mg/kg at 2.5 feet. TPH contamination at other sites were much lower ranging from ND to 125 mg/kg. Lead and BTEX levels are below PRGs. No additional chemicals of concern were identified in the human health risk assessment or the ecological risk assessment that requires remediation. However the same sample from AM-TP-1 where 4,650 mg/kg TPH was measured also contains 6,700 mg/kg of tentatively identified VOC compounds or TICs. Although the TICs may or may not require remediation, these compounds could potentially interfere with the effectiveness of a given technology. The estimated volume of soil that exceeds 10 mg/kg of TPH is 2,000 cubic yards. Figures 1.9a, 1.9b, 1.9c, and 1.9d show the areas of contamination at the Aircraft Maintenance storage areas. Figure 4.17 and 4.18 are site maps which show the concentrations of TPH.

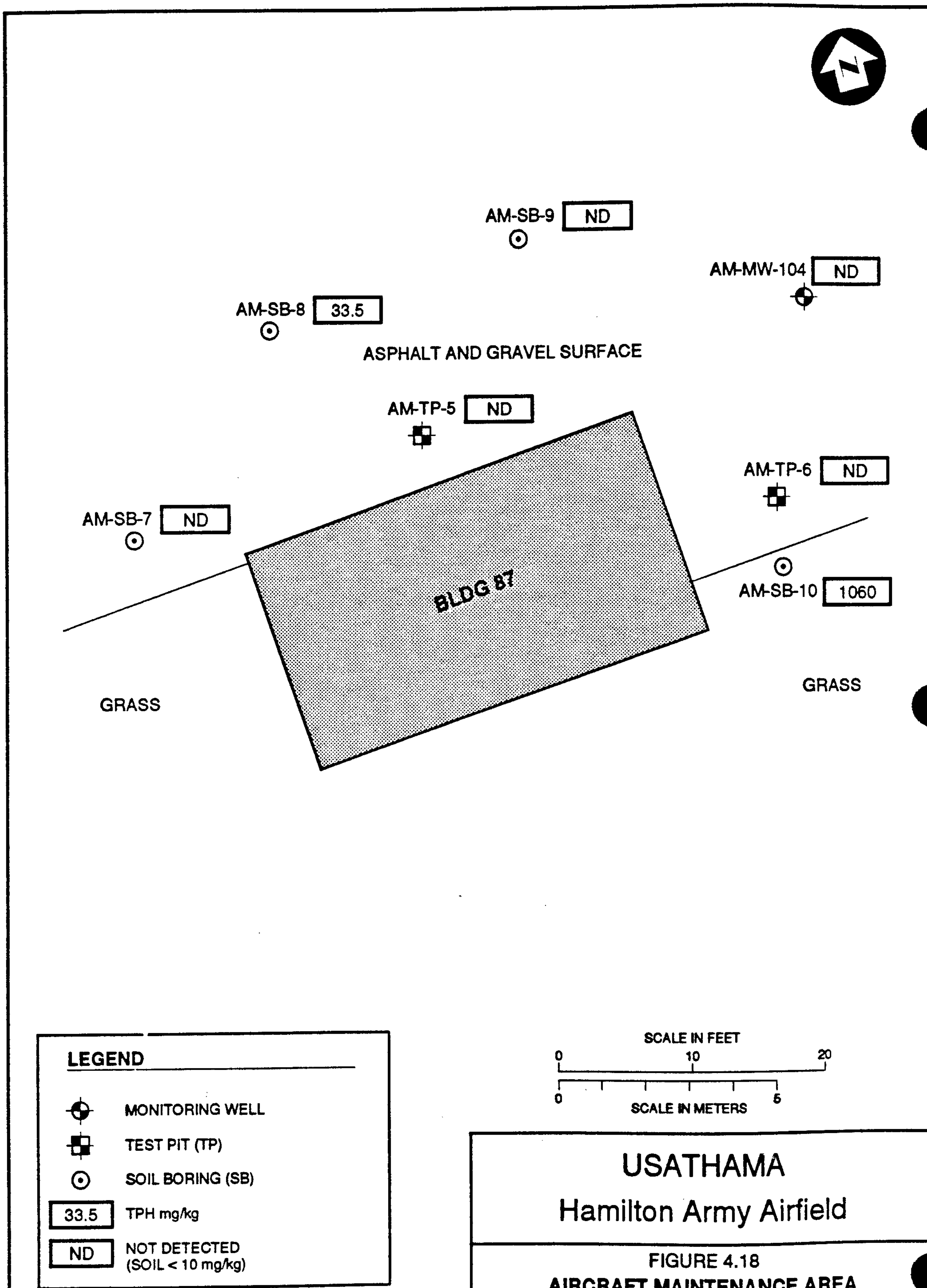
The only contaminants detected in soil samples at the Aircraft Maintenance site that exceeded PRGs were beryllium and arsenic. It appears that much of this site is covered with an imported gravelly backfill. Sample sites were selected in those areas that are not also covered by concrete or asphalt roadway, but instead were open to the elements. The beryllium concentrations throughout the site exceeded the upper background limit, however, only one sample (AM-SB-5) exceeded the calculated arsenic upper background limit. Those samples that exceeded the upper background limit were either taken in the backfill or at the top of the native soil. All samples taken in the bay mud were less than the calculated upper background limit. It is possible that the fill material was naturally high in beryllium and the contamination detected at this site is not attributed to past operating practices. Alternatives S2 (capping), and S7 (solidification/stabilization) are retained to address the pervasive beryllium levels at the site.

Two risk scenarios for soil exceed 1×10^{-6}: the risk to future residents (1.8×10^{-5}) and the calculated risk to base employees (1.6×10^{-5}). In both cases the hazard index is less than 1. Risk calculations are based on concentrations in surface soil 2 feet deep or less. Soil risks for both scenarios are entirely attributed to the presence of arsenic and beryllium. In fact the calculated risk based on beryllium alone is 4.1×10^{-6} for future resident scenario or 2.9×10^{-6} for the base employee scenario. Remediation would consist



USATHAMA
Hamilton Army Airfield

FIGURE 4.17
AIRCRAFT MAINTENANCE AREA
STORAGE AREAS 2 & 3 (OU1)
TPH CONCENTRATIONS IN SOIL



USATHAMA

Hamilton Army Airfield

FIGURE 4.18

AIRCRAFT MAINTENANCE AREA STORAGE AREA 4 (OU1) TPH CONCENTRACTIONS IN SOIL

REV.1 C335-15.DWG 04/26/94

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FIGURE 4.19

Evaluation of Soil Remedial Alternatives

Site 7: Aircraft Maintenance Area-Soils

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	Low	Low	Low	None	Moderate	Moderate	Low	None	525,000
TPH and Metals	S2/S6/S7: Excav. & Biotreat. Solidification/ Stabilization (d, f, h)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	906,000
	S2/S6/S12: Excav. & Biotreat Soil Washing (d, f, h)	Partial	Low	Low	Moderate	Partial	Partial	Low	Low	1,041,000
	S2/S8/S7: Excavation & Desorption Solidification/ Stabilization (d, f, h)	Moderate	Moderate	Moderate	Moderate	Partial	Moderate	Moderate	Partial	1,258,000
	S2/S8/S12: Excav. & Desorption Soil Washing (d, f, h)	Partial	Low	Low	Moderate	Partial	Partial	Partial	Low	1,308,000
	S2/S12: Excavation & Soil Washing (d, g, h)	Partial	Low	Low	Moderate	Partial	Partial	Partial	Low	1,044,000
Beryllium in Backfill	S7: Excavation & Solidification/ Stabilization (d, e)	Moderate	High	Moderate	Partial	Partial	Low	Partial	Partial	22,178,000
	S2: Asphalt Capping	Partial	None	Moderate	Low	Partial	Moderate	Moderate	Partial	501,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars. No Action Assumes 30 Years of Ground Water Monitoring. Monitoring Costs for Remedial Alternatives are Not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for Soil only Contaminated with Metals. The Entire Site is Over Laid with Backfill that has Beryllium Levels that Exceed the Native Soil Upper Background Limit

(f) This Alternative is Considered for Soils Contaminationed with TPH and Metals

(g) This Alternative is Considered for Soils Contaminated with TPH and Metals. Solvents can be used to Treat Organic and Metal Contaminants

(h) Alternative Includes 3 Feet of Non-Engineered Fill for Cover Material

and upper background limits in one sample. The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH and metal concentrations.

There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations.

Long-term effectiveness and permanence: This alternative would not be effective because there would be no reduction in the long-term risk for human and environmental receptors.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants through treatment. TPH concentration would diminish over a long time period. Beryllium and arsenic will likely remain unchanged.

Short-term effectiveness: The no action alternative, would have no impacts to the community, site workers, and environment resulting from the implementation of this alternative. However, contaminants would remain in the soil and potentially could impact the groundwater.

Implementability: Technically this alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-7.1.1. Capital costs of $25,000 are associated with installation of wells, and implementing site restrictions. Annual costs of approximately $53,000 are associated with monitoring and maintenance, which account for present work costs of $525,000 assuming 30 years of operation and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance would be difficult to attain because this alternative would not achieve the TPH soil cleanup goal of 10 mg/kg through treatment, and it does not address the risks associated with beryllium or arsenic.

Community acceptance: Community acceptance would also be difficult to attain due to public perceptions regarding land use and lack of active treatment of contaminants.

4.7.1.2 S2: Capping (Aircraft Maintenance - Soil). There are two types of capping considered for the Aircraft Maintenance soils: capping with asphalt, and covering with 3 feet of non-engineered fill. Capping with asphalt provides a barrier that has low permeability over the area contaminated, which will protect against exposure to humans and wildlife. Deed restrictions and periodic monitoring would assure the cap remains an effective barrier. Capping with asphalt limits infiltration of precipitation through contaminated areas. The capping with asphalt is considered in order to provide protection from the beryllium found in the backfill at Aircraft Maintenance and the

arsenic at AM-SB-5. Most of the area near Building 86 (Figure 4.17) is already capped with buildings, concrete, and asphalt. This alternative involves laying asphalt over areas where the existing asphalt has cracks and applying asphalt over the patches of dirt and grass in the area. Approximately 68,600 square yards would be capped (that is not already capped) with this alternative.

Covering the contaminated area with 3 feet of non-engineered fill is a variation of the capping alternative. The cover material does not significantly reduce infiltration but can provide a barrier to exposure for humans and the environment. Covering is considered in order to provide protection to beryllium and involves the same area considered for capping with asphalt. This technology has been combined with all but one of the alternatives evaluated for the Aircraft Maintenance Site. Since beryllium appears pervasive throughout the fill material imported to the site, the cover area was selected to include any areas where activities took place that is not already covered by concrete, asphalt, or a building. Approximately 68,600 cubic yards of fill material is needed at Aircraft Maintenance.

The sequence of activities that would be performed for capping with asphalt include:

- Grading the area covered with dirt or grass;
- Applying 2 inches of asphalt over the affected areas not already capped.

The sequence of activities involved with the cover variation include:

- Applying 3 feet of fill over the affected areas. The fill does not require grading or compacting.

Protection of human health and the environment: The asphalt capping or covering with fill alternatives are currently protective of human health and environment because the asphalt cap or the cover will protect against exposure to people and to biota.

Compliance with ARARs: The PRG for beryllium is 0.149 mg/kg and no clean up levels have been established to provide protection to the underlying groundwater. Capping or covering would not assist in complying with the PRG but would reduce exposure to biota. Capping with asphalt would reduce infiltration.

Location specific ARARs appear to be satisfied because the burrowing owl (a listed endangered species), would not be able to burrow under the asphalt cap or the cover, and thus could not come in contact with the contamination.

Long-term effectiveness and permanence: The capping and covering alternatives would not be directly effective in removing residual contamination. However, both capping and covering will prevent exposure to people and to biota. Asphalt will also prevent infiltration, which would have spread the contaminants.

Reduction of toxicity, mobility, or volume through treatment: The capping and covering alternatives would do almost nothing to directly reduce the toxicity, mobility, or volume of contaminants. Contaminant migration would be reduced by capping with asphalt.

Short-term effectiveness: Site workers may be exposed to contamination while grading the dirt and to asphalt fumes while paving the area. Engineering controls and personal protection equipment would reduce exposure.

Implementability: Capping the site with 2 inches of asphalt or covering with 3 feet of fill is readily implemented, and the equipment needed is readily available.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-7.1.9 (asphalt) in Appendix D. The capital cost for applying fill is included in the soil remedial alternatives. The capital cost for applying asphalt is estimated to be $501,000, and the capital cost for applying 3 feet of fill is $412,000. It is assumed that groundwater monitoring would continue to 20 years and details pertaining to those costs are in Table DWM-7. The present worth cost is the same as the capital cost since the project could be completed in less than one year.

State acceptance: Regulatory acceptance should be attainable since either capping or covering would protect against exposing humans and the environment to the beryllium in the backfill and the arsenic at AM-SB-5.

Community acceptance: Community acceptance should be attainable since capping or covering would reduce exposure to beryllium in the backfill and the arsenic at AM-SB-5.

4.7.1.3 S2/S6/S7: Excavation, Capping and Biotreatment followed by Solidification/ Stabilization (Aircraft Maintenance - Soil). Biological treatment followed by solidification/stabilization is a treatment alternative effective in treating organic contaminants by biological treatment followed by residual metals management. The process begins with conventional biological treatment. Soils are excavated and placed in a controlled treatment unit. The soil is aerated either mechanically by tilling or possibly through vent pipes placed in soil piles. A blower would draw the air through the pile. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade a wide range of organics including TPH. Nutrients or special microorganisms can also be added to entrance the remediation process. A process flow diagram is shown in Appendix E.

Upon completion of the bioremediation, solidification additives are mixed with the soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization would be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposed of in a landfill.

Biodegradation would be successful in degrading the TPH contamination. Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in similar applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit (possible including vent pipes and blowers)
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or draw air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Application of solidification agents
- TCLP metals analysis
- Backfilling and compaction of the excavation, and
- Regrading the site

Protection of human health and the environment: Biodegradation followed by solidification/stabilization should be effective in protecting human health and the environment because they are demonstrated effective technologies for degrading and immobilizing the chemicals of concern at this site.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH remedial action objective may be attained, and solidification/stabilization could effectively immobilize beryllium and arsenic. However, the presence of the TICs could interface with attaining ARARs and a treatability study is recommended.

All the action specific ARARs that apply to excavation and biotreatment and solidification/stabilization would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Lead and other metal analysis are not significantly high and very likely the soil would meet TCLP criteria without special treatment.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during the design phase of this alternative.

Long-term effectiveness and permanence: Bioremediation followed by solidification/stabilization appears to be protective in the long-term due to the technology's effectiveness in degrading and immobilizing the chemicals of concern. However, the TICs in the contaminated area may reduce the effectiveness of bioremediation and of solidification/stabilization. A treatability study is needed to determine the effectiveness of this alternative.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the toxicity and volume of the organic contaminants and solidification/stabilization would immobilize the heavy metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however engineering controls and personal protection equipment would reduce exposure. Organic contaminants would be removed and metals established so that potential groundwater would be protected.

Implementability: Bioremediation followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.1.2 in Appendix D. Remediation of soil contaminated with TPH and metals involves excavating and treating 1,940 cubic yards of soil. Capital costs are estimated to be $735,000 and are estimated to be $99,000 per year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is estimated to be $906,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to these technology's proven effectiveness in remediating the chemicals of concern in soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.7.1.4 S6/S12: Excavation, Capping and Biotreatment followed by Soil Washing (Aircraft Maintenance - Soil). Biological treatment followed by soil washing is a treatment alternative effective in treating organic contaminants by biological treatment followed by residual metals treatment. The process begins with conventional biological treatment. Soils are excavated and placed in a controlled treatment unit. The soil is aerated either mechanically or passively through vent pipes placed in soil piles. A blower would draw air through the piles. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade a wider range of organics including TPH. Nutrients or special microorganisms can also be added to enhance the remediation process. A process flow diagram is shown in Appendix E.

Upon completion of the bioremediation, the soil contaminated with residual metals is washed with a washing solution. The washing solution extracts residual metal

contaminants from the soil. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After treatment, the detoxified soil can be returned to the excavation on site or disposed of in a landfill. The washing solution may require treatment prior to discharge.

Biodegradation would be successful in degrading the TPH. Soil washing has been successful in reducing beryllium and arsenic levels in bench scale tests (EPA 1990c). Assuming the same removal efficiency of 89%, the average beryllium concentration would be reduced from 1.4 mg/kg to 0.15 mg/kg. This value for treated soil concentrations is identical to the beryllium PRG 0.149 mg/kg. Even after treatment, half the soil samples will still exceed the PRG. Even though only one sample exceeded the arsenic upper limit, HAA soils are naturally high in arsenic as indicated by background soils exceeding PRG concentrations. None of the samples where arsenic was detected would be reduced to PRGs for arsenic by soil washing.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils and nutrients as needed
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Treat soils with washing solution
- Sample treated soil to monitor contaminant removal
- Dewater treated soils
- Treatment of waste water (washing solution)
- Backfill and compaction of the excavation, and
- Regrade site

Protection of human health and the environment: Biodegradation followed by soil washing should be effective in protecting human health and the environment. Beryllium and arsenic would still exceed PRGs but now would be within background levels. Contaminants would be transferred to a solvent medium which would then require treatment.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH cleanup goal may be attained. A pilot study is recommended to determine degradation rates. The average beryllium concentration

would comply with PRG. However, by definition of average, half the samples would still exceed the beryllium preliminary remediation goal. Arsenic would still exceed the PRG.

All the action specific ARARs that apply to excavation and biotreatment followed by soil washing would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during the design phase of this alternative.

Long-term effectiveness and permanence: Bioremediation followed by soil washing is not protective in the long-term since soil washing is not effective in attaining PRGs for arsenic.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the toxicity and volume of the organic contaminants and soil washing would remove beryllium and arsenic. However, it is not likely that arsenic concentration would be reduced to PRGs.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. Thermal desorption produces emissions and soil washing generates a spent waste solution. Both emissions and washwater require treatment. However, with engineering controls and personal protection equipment the technology can be implemented with minimal exposure to workers. The source of TPH contamination would be removed from the soil. Arsenic would still exceed PRGs.

Implementability: Bioremediation followed by soil washing may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.1.3 in Appendix D. Remediation of soil contaminated with TPH and metals involves excavating and treating 1,940 cubic yards of soil. Capital costs are estimated to be $935,000 and are estimated to be $61,000 per year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is estimated to be $1,041,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance is not likely since soil washing is not effective in reducing arsenic concentrations to the PRG.

Community acceptance: Community acceptance is not likely since soil washing is not effective in reducing arsenic concentrations to the PRG.

4.7.1.5 S8/S7: Excavation, Capping and Low Temperature Thermal Desorption followed by Solidification/Stabilization (Aircraft Maintenance - Soil). Low temperature thermal desorption followed by solidification/stabilization is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Solidification additives are then mixed with the treated soils from the thermal desorption unit. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposal in a landfill.

Low temperature thermal desorption would be successful in stripping the TPH contamination. Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Application of solidification agents
- TCLP metals analysis
- Backfill and compaction of the excavation
- Regrade site, and
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: Low temperature thermal desorption followed by solidification/stabilization should be effective in protecting human health and the environment because they are demonstrated effective technologies for removing and immobilizing the chemicals of concern at this site.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH cleanup goal may be attained. However, if heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm. Solidification/stabilization could effectively immobilize beryllium and arsenic. However, the TICs present could interfere with attaining ARARs and a treatability study is recommended.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption followed by solidification/stabilization would be met. Action specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption followed by solidification/stabilization appears to be protective in the long-term due to the technology's effectiveness in removing and immobilizing the chemicals of concern. However, the tentatively identified VOCs could reduce the effectiveness of this alternative.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the toxicity and volume of the organic contaminants and solidification/stabilization would immobilize the heavy metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. It may be possible to effectively implement this alternative by using engineering controls and personal protection equipment. Contaminant source would be removed and groundwater is protected. Remediation time is expected to be one year. If the TICs are volatile and desorbed, capturing the contaminants in the exhaust may be difficult without first knowing what the TICs are.

Implementability: Low temperature thermal desorption followed by solidification/stabilization may be readily implemented as they are proven technologies,

components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.1.4 in Appendix D. Remediation of soil contaminated with TPH and metals involves excavating and treating 1,940 cubic yards of soil. Capital costs are estimated to be $1,258,000 and the project will last six months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance may be difficult without a treatability test and without know more about the TICs.

Community acceptance: Community acceptance may be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable. However, the anticipated public resistance to thermal treatment processes in their communities may not be favorable.

4.7.1.6 S8/S12: Excavation, Capping and Low Temperature Thermal Desorption followed by Soil Washing (Aircraft Maintenance - Soil). Low temperature thermal desorption followed by soil washing is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Upon completion of low temperature thermal desorption treatment, the soil contaminated with residual metals is washed with a washing solution. The washing solution extracts the residual metal contaminants from soil. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After treatment, the detoxified soil can be returned to the excavation on site.

Low temperature thermal desorption would be successful in stripping the TPH contamination. Soil washing has been successful in reducing beryllium and arsenic levels in bench scale tests (EPA 1990c). Assuming the same removal efficiency of 89%, the average beryllium concentration would be reduced from 1.4 mg/kg to 0.15 mg/kg. This value for treated soil concentrations is identical to the beryllium PRG 0.149 mg/kg. Even after treatment, half the soil samples will still exceed the PRG. Even though only one sample exceeded the arsenic upper limit, HAA soils are naturally high in arsenic. None of the samples where arsenic was detected would be reduced to PRGs for arsenic by soil washing.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment units and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to thermal processing system
- Transfer treated soil to storage pad for temporary storage
- Treat soils with washing solution
- Sample treated soil to monitor contaminant removal
- Dewater treated soils
- Treatment of waste water (washing solution)
- Backfill and compaction of the excavation
- Regrade site, and
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: Low temperature thermal desorption followed by soil washing should be effective in protecting human health and the environment. Beryllium and arsenic would still exceed PRGs, but now would be within background levels. Contaminants would be transferred to a solvent medium which would then require treatment.

Compliance with ARARs: A process flow diagram is shown in Appendix E. However, a cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm. Beryllium would still exceed PRGs but could possibly be within background levels. The average beryllium concentration would comply with PRG. However, by definition of average, half the samples would still exceed the beryllium preliminary remediation goal. Arsenic would still exceed the PRG. A treatability study is needed to determine the effectiveness of soil washing on Aircraft Maintenance soil.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption followed by soil washing would be met. Action specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studies during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption followed by soil washing is not protective in the long-term since soil washing is not effective in attaining PRGs for arsenic.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the toxicity and volume of the organic contaminants and soil washing would remove beryllium and arsenic. However, it is not likely that arsenic concentrations would be reduced to PRGs.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. It may be possible to effectively implement this alternative by using engineering controls and personal protection equipment. The sources of TPH contamination would be removed from the soil. Arsenic would continue to exceed PRGs. If the TICs are volatile and desorbed, capturing the contaminants in the exhaust may be difficult without knowing more about the TICs.

Implementability: Low temperature thermal desorption followed by soil washing may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.1.5 in Appendix D. Remediation of soil contaminated with TPH and metals involves excavating and treating 1,940 cubic yards of soil. Capital costs are estimated to be $1,308,000 and the project is estimated to take six months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance is not likely since soil washing is not effective in reducing arsenic concentrations to the PRG and without knowing more about the TICs.

Community acceptance: Community acceptance is not likely since soil washing is not effective in reducing arsenic concentrations to the PRG. Also, the anticipated public resistance to thermal treatment processes in their communities may not be favorable.

4.7.1.7 S6/S7: Excavation, Capping and Solidification/ Stabilization (Aircraft Maintenance - Soil). The soil solidification/stabilization consists of applying solidification additives with the soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and

effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

This alternative is included should it be necessary to remove beryllium which is pervasive in the top 2 feet of imported fill material covering the site. This alternative is also considered for treating soils near AM-SB-5 which exceed background and PRG for arsenic. The soil could possibly be treated by a soil recycling company that will produce an aggregate material and certification of remediation to the generator. The soils must conform to an acceptable materials profile (specific to the recycler) and cannot be considered hazardous by CalEPA.

Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988). A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit
- Excavation of contaminated soils and placement in treatment unit
- Application of solidification agents
- TCLP metals analysis
- Backfill and compaction of the excavation, and
- Regrade site

Existing structures would be left in place which will act as a barrier from exposure pathways.

Protection of human health and the environment: Solidification/stabilization should be effective in protecting human health and the environment because they are demonstrated effective technologies for immobilizing the chemicals of concern at this site.

Compliance with ARARs: Soil solidification stabilization can likely immobilize TPH and metals. This would be verified by a pilot test prior to implementing this technology.

All the action specific ARARs that apply to excavation and biotreatment and solidification/stabilization would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands,

critical habitats and endangered species protection must be studies during design phase of this alternative.

Long-term effectiveness and permanence: Solidification/stabilization appears to be protective in the long-term due to the technology's effectiveness in immobilizing the chemicals of concern.

Reduction of toxicity, mobility, or volume through treatment: Solidification/ stabilization would immobilize TPH and the heavy metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however engineering controls and personal protection equipment would reduce exposure. Contaminants would be immobilized so that potential groundwater would be protected.

Implementability: Solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.1.6 in Appendix D. The remediation of the soil near AM-SB-5 contaminated with beryllium and arsenic (no TPH) involves excavations and treating 40 cubic yards of soil. Capital costs are estimated to be $17,000.

The aircraft maintenance site contains elevated levels of beryllium. Remediation of the entire site for metals involves excavating and treating 147,780 cubic yards of soil. The estimated cost for this alternative and assumptions used are presented in Table D-7.1.7 in Appendix D. Capital costs are estimated to be $22,178,000.

State acceptance: Regulatory acceptance should be attainable provided that bench scale testing demonstrates that both TPH and metals are effectively immobilized.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.7.1.8 S12: Excavation, Capping and Soil Washing (Aircraft Maintenance - Soil). Direct soil washing is a chemical/physical treatment method for organic and heavy metal contaminated soils. It extracts contaminants from soil by a washing solution such as water, organic solvents, surfactants, acids, or bases. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Sequential washing steps would likely be needed since very different washing solutions are needed to treat TPH and to treat for metals. After treatment, the detoxified soil can be returned to the excavation as fill material. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad

- Screen all material larger the .25 inches from soil
- Shred material larger than .25 inches
- Convey soils to processing system
- Treat soils with washing solution
- Dewater treated soils
- Sample treated soil to monitor contaminant removal
- Treatment of waste water (washing solution)
- Backfill and compaction of the excavation, and
- Regrade site

Protection of human health and the environment: Soil washing is a demonstrated effective technology for the treatment of particular organic and heavy metal contaminants in soil. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Therefore, a treatability study would need to be completed to determine the technology's effectiveness for the chemicals of concern. Beryllium and arsenic would still exceed PRGs but would be within background levels for HAA. Contaminants would be transferred to a solvent medium which would then require treatment.

Compliance with ARARs: A soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. A treatability study would be necessary to select appropriate washing solutions and post treatment of the washwater. The average beryllium concentration would comply with PRG. However, by definition of average, half the samples would still exceed the beryllium PRG. Arsenic would still exceed the PRG. A treatability study is needed to determine the effectiveness of soil washing on aircraft maintenance soils.

All the action specific ARARs that apply to excavation and soil washing may be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil if determined to be a RCRA waste, RCRA land disposal restriction will apply.

If the technology proves to be effective for the chemical of concern, location specific ARARs (critical habitat/or and endangered or threatened species) would be satisfied because the expected environmental risk would be reduced and care would be taken during implementation of the alternative to not affect the endangered species or critical habitat.

Long-term effectiveness and permanence: Soil washing may not be protective in the long-term since soil washing is not effective in attaining PRGs for arsenic.

Reduction of toxicity, mobility, or volume through treatment: Soil washing may reduce the toxicity, mobility, and volume of the contaminants at the site. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. Engineering controls and personal protection equipment would reduce exposure. The process would remove the contaminants from the soils. Arsenic concentrations may still exceed PRGs.

Implementability: Soil washing may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.1.8 in Appendix D. Remediation of the soil contaminated with TPH and metals involves excavating and treating 1,940 cubic yards of soil. Capital costs are estimated to be $1,044,000 and the project is estimated to take ten months. It assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance is not likely since soil washing is not effective in reducing arsenic concentrations to the PRG.

Community acceptance: Community acceptance is not likely since soil washing is not effective in reducing arsenic concentrations to the PRG.

4.7.2 Sediment Contamination

Sediment contamination is generally confined to the concrete vaults storm water collection vault and the sediments can be removed from the vaults and treated. It is possible, however, that if there are cracks in the stormwater drainage system, then contamination may have infiltrated into the subsurface. Sediments contain high levels of TPH throughout the site ranging from 230 mg/kg to 2,500 mg/kg. Lead concentrations as high as 1,020 mg/kg were found in one vault with an average concentration of 419 mg/kg from all the vaults sampled. Benzo[a]pyrene (BAP) was detected in four vaults that exceed the PRG. Beryllium and arsenic were detected at levels that exceed their PRGs and background levels. No additional analytes were identified by the ecological risk assessment.

The hazard index for ingestion by potential future residents is 2. The two compounds which account for the majority of the risk are cadmium (hazard index = 0.68) and chromium (hazard index = 0.77). Cadmium was not detected in the background samples but was found in 6 of 10 aircraft maintenance sediment samples. Sample concentrations for cadmium ranged from non-detect to 6.85 mg/kg, however AM-SD-1 was 29.1 mg/kg and AM-SD-2 was 68.4 mg/kg. Sediments from both concrete vaults also require remediation because of elevated lead concentrations. Chromium (Cr) was detected in all 10 samples analyzed but exceeded background limit (160.9 mg/kg) at two concrete vaults, AM-SD-2 (711 mg/kg) and AM-SD-8 (215 mg/kg). Again both concrete vaults also require remediation because of elevated lead concentrations. The risk factors used to

calculate the hazard index are based on Chromium VI data. The reported total chromium concentration does not distinguish between Cr III or Cr VI which can lead to a high estimate of the actual hazard index because the toxicity of Cr VI is assumed to dominate. Technologies that are used to treat lead will also fixate or remediate cadmium and chromium.

Only one sediment sample was collected from the drainage channel which ultimately collects the storm water run off. Sample AM-SD-3 is contaminated with TPH (1,240 mg/kg) and beryllium. No other analytes of concern were identified in the sample. The drainage channel runs along the site boundary just inside the levee crest. For the purposes of estimating volume of soil to be treated it was assumed that the contamination in the channel extends 2,400 feet over a ten foot wide span (1,780 cubic yards). The Corps of Engineers will collect additional samples to better characterize the drainage channel. Metal and SVOC contaminants were identified that exceed the with-cover sediment screening criteria. The channel has been assigned to Operable Unit 2. The volume of sediments from the vaults is 10 cubic yards. Figures 4.20 and 4.21 are site maps showing the locations of TPH and non-TPH contamination.

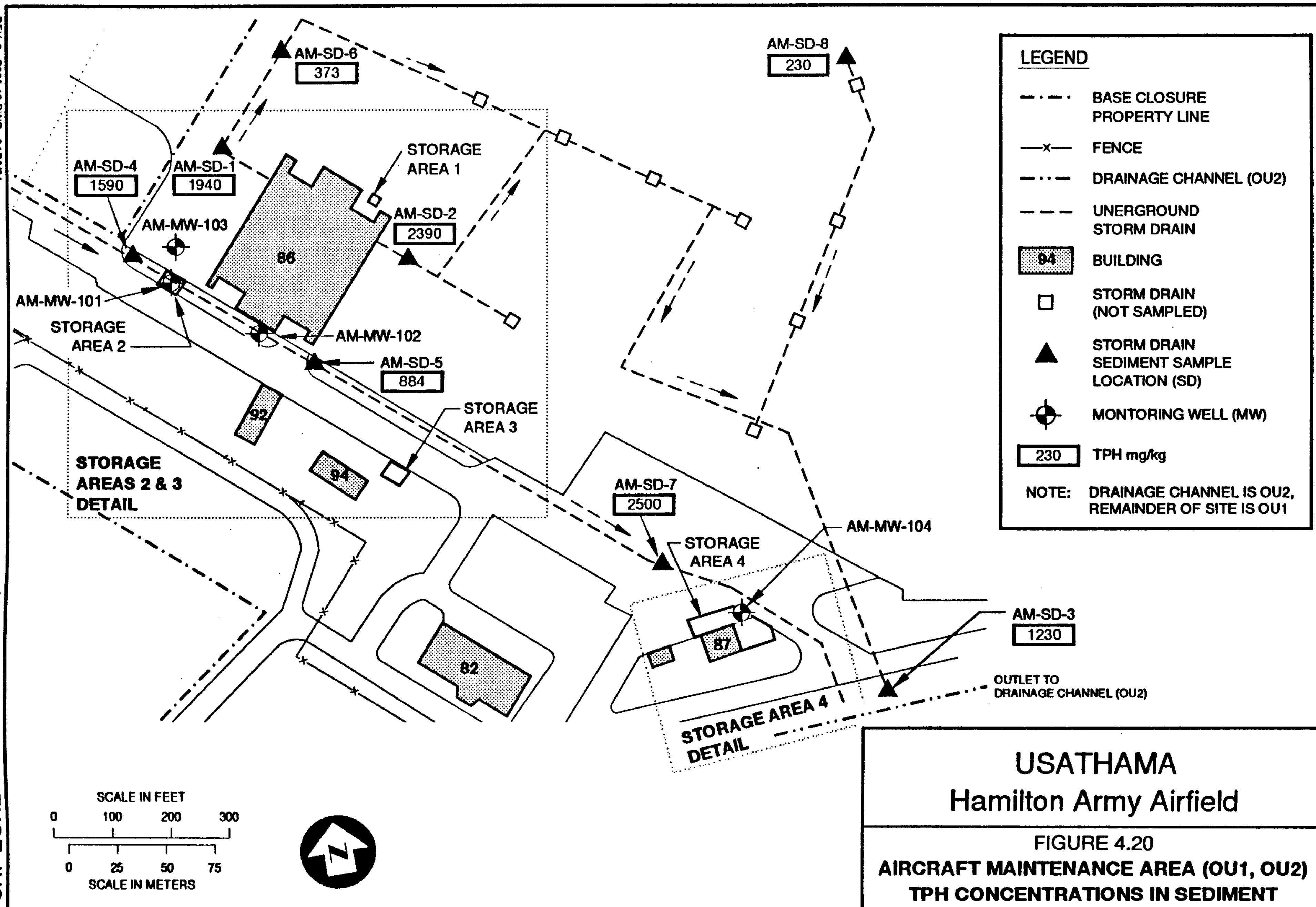
Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S2/S6/S7: Excavation, Capping and Biotreatment followed by Solidification/Stabilization;
- S2/S8/S7: Excavation, Capping and Low Temperature Thermal Desorption followed by Solidification/Stabilization; and
- S9/S7: Excavation and Thermal Destruction followed by Solidification/Stabilization.

Soil washing was not considered since it cannot attain PRGs for many of the heavy metals which are pervasive in the storm drain sediments. Solidification/stabilization was not considered because it is not effective for high concentrations of organic (TPH) contamination.

The following four sections present the evaluation for the four alternatives relative to the evaluation criteria. Additionally, Figure 4.22 presents the summary of the detailed analysis of the each remedial alternative retained relative to the evaluation criteria. This figure is subdivided by types of contaminants. Certain alternatives are more applicable to specific types of contaminants and costs have been estimated assuming a given chemistry and volume for similar contamination. At least one alternative from each category needs to be selected and combined with the other selected alternatives for a final remedy.

4.7.2.1 S1: No Action (Aircraft Maintenance - Sediment). The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for sediments at this site would consist of leaving the sediments in place and not applying any remedial treatment. Land use

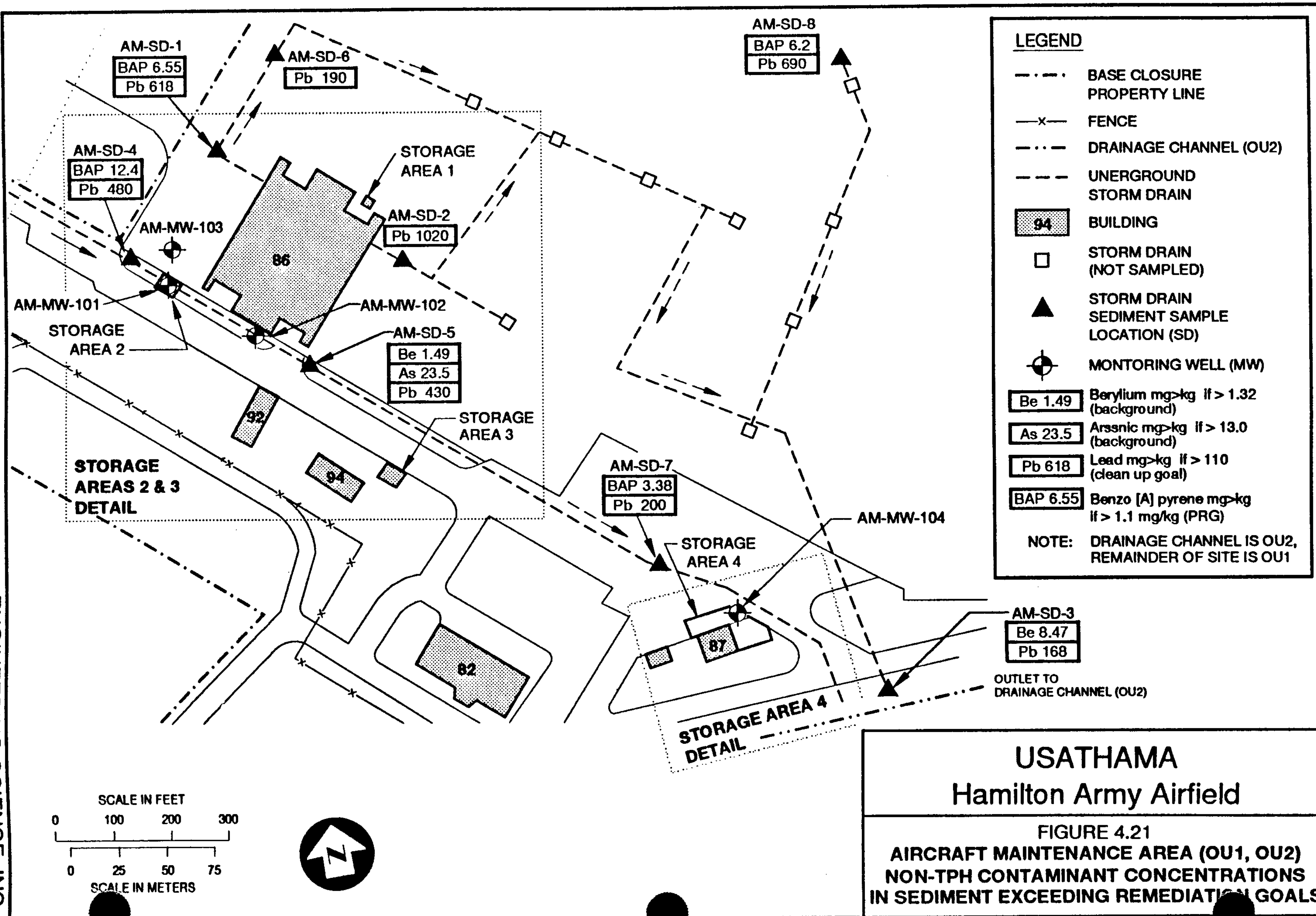


USATHAMA
Hamilton Army Airfield

FIGURE 4.20
AIRCRAFT MAINTENANCE AREA (OU1, OU2)
TPH CONCENTRATIONS IN SEDIMENT

REV. 3 C335-12.DWG 04/26/94

ENGINEERING-SCIENCE, INC.



USATHAMA
Hamilton Army Airfield

FIGURE 4.21
AIRCRAFT MAINTENANCE AREA (OU1, OU2)
NON-TPH CONTAMINANT CONCENTRATIONS
IN SEDIMENT EXCEEDING REMEDIATION GOALS

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FIGURE 4.22

Evaluation of Soil Remedial Alternatives

Site 7: Aircraft Maintenance Area-Sediments

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Perman-ence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implement-ability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	◔	◔	○	○	◕	◕	○	○	525,000
TPH and Metals (Perimeter Ditch)	S2/S6/S7: Excav. & Biotreat. Solidification/ Stabilization & Capping (d, f)	◕	◕	◕	◕	◑	◕	◕	◕	518,000
	S2/S8/S7: Thermal Desorption Solidification/ Stabilization & Capping (d, f)	◕	◕	◕	◕	◔	◕	◑	◑	847,000
TPH, SVOCS, and Metals (Storm Drains)	S9/S7: Thermal Destruction Solidification/ Stabilization (e)	●	●	●	●	◕	◕	◕	◕	45,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars No Action Assumes 30 Years of Ground Water Monitoring. Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative Applies to the Estimated 10 C.Y. OF Sediment in the Storm Drains. The Remaining Alternatives refer to Sediments in the Drainage Channel (TPH, Metals)

(f) Capping is 3 Feet of Non-Engineered Fill.

restrictions are necessary to warn and limit receptor access to the site because of the expected risk to human health.

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to human health and the environment would not change. This alternative does not fulfill the intent of the CERCLA/SARA by providing permanent protection of human health and the environment.

Compliance with ARARs: There are no chemical specific ARARs pertaining to sediments in the vaults for the chemicals of concern. The sediment at aircraft maintenance site is isolated from the subsurface and groundwater by the concrete vault enclosure. A soil cleanup goal for TPH (10 mg/kg) has been established for the protection of groundwater from the sediments in the drainage channel. The no action alternative would not be in compliance with remedial action objectives because of the elevated TPH and beryllium concentrations.

There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs (critical habitat/or and endangered or threatened species) apply at HAA because animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Plant species at HAA are not endangered by the no-action scenario for aircraft maintenance sediments.

Long-term effectiveness and permanence: It is conceivable that cracks could develop in the concrete vault and contaminants could leach into the subsurface. The no action alternative would not be effective because there would be no reduction in the long-term risk for human and environmental receptors.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-term effectiveness: The no action alternative, would have no impacts to the community, site workers, and environment resulting from the implementation of this alternative. If cracks should develop in the vault, the contaminants could impact the groundwater. Also, contaminants left in the drainage channel could potentially impact groundwater.

Implementability: Technically this alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-7.2.1. Capital costs of $25,000 are associated with installation of wells, and implementing site restrictions. Annual costs of approximately $53,040 are associated with no monitoring and maintenance, which account for present work costs of $525,000 assuming 30 years of operation and a 10 percent annual interest rate.

State acceptance: Regulatory acceptance would be difficult to attain because this alternative does not address the risk to the environment.

Community acceptance: Community acceptance would also be difficult to attain due to public perceptions regarding land use and lack of active treatment of contaminants.

4.7.2.2 S6/S7: Excavation, Capping and Biotreatment followed by Solidification/ Stabilization (Aircraft Maintenance - Sediment). Biological treatment followed by solidification/stabilization is a treatment alternative effective in treating organic contaminants followed by residual metals management. The process begins with conventional biological treatment. Soils are excavated and placed in a controlled treatment unit. The soil is aerated either mechanically by tilling or passively through vent pipes placed in soil piles. A blower would draw the air through the pile. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade a wide range of organics including TPH. Nutrients or special microorganisms can also be added to the remediation process. A process flow diagram is shown in Appendix E.

Upon completion of the bioremediation, solidification additives are mixed with the sediment. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposed of in a landfill off site.

Biotreatment would be successful in degrading TPH and benzo[a]pyrene from the those concrete vaults that do not also contain elevated metal concentrations. High levels of metals are toxic to the organisms and arsenic is particularly detrimental to biotreatment (EPA 1990c). Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988). Biotreatment followed by solidification/ stabilization is considered for sediments in the perimeter ditch, which is contaminated with TPH and metals.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit (possibly including vent pipes and blowers)
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or draw air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Application of solidification agents
- TCLP metals analysis, and
- Disposal of treated sediment

Protection of human health and the environment: Biodegradation followed by solidification/stabilization should be effective in protecting human health and the environment because they are demonstrated effective technologies for degrading and immobilizing the chemicals of concern at this site.

Compliance with ARARs: The sediment at the aircraft maintenance unit is isolated from the subsurface and groundwater by the concrete vault enclosures. The soil cleanup goal for TPH (10 mg/kg) for the protection of groundwater does not apply to those sediments. Soils in the drainage channel exceed the 10 mg/kg TPH cleanup goal for the protection of groundwater. Bioremediation is effective in treating TPH contamination. Under favorable conditions the TPH remedial objective may be attained. A pilot study is recommended to determine degradation rates. Solidification/stabilization could effectively immobilize beryllium.

All the action specific ARARs that apply to excavation and biotreatment and solidification/stabilization would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment and disposal. These requirements may require compliance to RCRA waste levels if the soil is determined to be RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during design phase of this alternative.

Long-term effectiveness and permanence: It is conceivable that cracks could develop in the concrete vault and contaminants could eventually leach into the subsurface. Bioremediation followed by solidification/stabilization may not be protective in the long-term for all the sediments at the aircraft maintenance site since the elevated metals concentrations would impact bioremediation treatment effectiveness. Concrete vaults where sample AM-SB-4, 6, and 7 appear to be low in metal contamination. Biotreatment may be effective for organic contaminants from these concrete vaults. Bioremediation followed by solidification/stabilization appears to be protective for sediments in the drainage channel.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation may not reduce the toxicity and volume of the organic contaminants in the concrete vaults because of the presence of heavy metals in the sediment. However, solidification/stabilization would immobilize the chemicals of concern. Bioremediation would reduce the toxicity and volume of TPH in the drainage channel sediments and solidification/stabilization would immobilize beryllium.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however engineering controls and personal protection equipment would reduce exposure. Organic

contaminant concentrations would be reduced and metals immobilized so that groundwater would be protected.

Implementability: Bioremediation followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.2.2 in Appendix D. Capital costs are estimated to be $357,000 and annual costs are estimated to be $92,000 per year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is estimated to be $518,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance is not likely for sediments in the concrete vaults given problems associated with metals in reducing biotreatment effectiveness. Regulatory acceptance should be attainable for the sediments in the drainage channel.

Community acceptance: The community would not likely accept biotreatment because of potential problems in treating the contaminants in the storm water concrete vaults. Community acceptance should be attainable for treating the drainage channel sediments.

4.7.2.3 S8/S7: Excavation, Capping and Low Temperature Thermal Desorption followed by Solidification/Stabilization (Aircraft Maintenance - Sediment). Low temperature thermal desorption followed by solidification/stabilization is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated sediments and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Solidification additives are then mixed with the treated sediments from the thermal desorption unit. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

Low temperature thermal desorption would be successful in stripping the TPH contamination, however may not effectively treat benzo[a]pyrene. The four (out of eight) concrete vaults where benzo[a]pyrene was detected may require additional treatment. A pilot test is needed to evaluate effectiveness in treating benzo[a]pyrene down to PRGs. Three of the concrete vaults had detectable levels of chlorinated hydrocarbons which

could produce HCl in the emissions. Control of emissions would be needed if those sediments containing chlorinated compounds are treated by thermal desorption.

Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988). Thermal desorption followed by solidification/stabilization is considered for sediments in the perimeter ditch, which is contaminated with TPH and metals.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Application of solidification agents
- TCLP metals analysis, and
- Dispose of treated sediment

Protection of human health and the environment: Low temperature thermal desorption followed by solidification/stabilization should be effective in protecting human health and the environment. Soil solidification/stabilization is a demonstrated effective technology for immobilizing the metal contamination at this site.

Compliance with ARARs: The sediment at the aircraft maintenance unit is isolated from the subsurface and groundwater by the concrete vault enclosures. The soil cleanup goal for TPH (10 mg/kg) for the protection of groundwater applies to sediments in the drainage channel. If heavy hydrocarbons or oils are present, this thermal desorption may not be able to remove all of the contamination. A treatability study is also needed to confirm. Solidification/stabilization could effectively immobilize beryllium.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption followed by solidification/stabilization would be met. Action specific ARARs include excavation, stockpiling, air emissions, and disposal. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands,

critical habitats and endangered species protection must be studies during design phase of this alternative.

Long-term effectiveness and permanence: It is conceivable that cracks could develop in the concrete vault and contaminants could eventually leach into the subsurface. Low temperature thermal desorption followed by solidification/stabilization may be protective in the long-term due to the technology's effectiveness in removing and immobilizing the chemicals of concern.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the toxicity and volume of the organic contaminants and solidification/stabilization would immobilize the heavy metals. However, because BAP has a low vapor pressure it may not be effectively treated by thermal desorption. A pilot study is needed to demonstrate removal efficiency.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Contaminant source would be removed and groundwater is protected. Remediation time is expected to be one year.

Implementability: Low temperature thermal desorption followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-7.2.3 in Appendix D. Capital costs are estimated to be $847,000 and the project is estimated to take six months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-7. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance would depend on the results of a pilot study. Regulatory acceptance should be attainable for the sediments in the drainage channel.

Community acceptance: Community acceptance may be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable. However, the anticipated public resistance to thermal treatment processes in their communities may not be favorable.

4.7.2.4 S9/S7: Excavation, and Thermal Destruction followed by Solidification/Stabilization (Aircraft Maintenance - Sediment). This alternative involves removing the sediments from the concrete vaults, possibly containerizing the sediments, and transporting to an approved treatment facility for incineration. This alternative also includes sealing each of the storm drains, other connections to the storm drain system, and the outfall pipe. This will isolate the stormwater system and minimize infiltration of water through any cracks that may be present in the pipes. Treatment of

contaminated soil involves incineration at high temperature (>2000° F) to destroy the contaminants. The treatment facility is responsible for and will certify the destruction of the waste, treatment of the off-gas, and final disposal of incinerator residuals (ash). A process flow diagram is shown in Appendix E.

Disposal of the incineration ash would require solidification if heavy metal concentrations exceed action specific ARARs requiring treatment of the residual ash prior to land disposal. The process involves the addition of solidification additives mixed with the residual ash. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

A significant portion of the cost for off-site incineration is transportation, because California does not have a commercial incineration facility. For costing purposes, the Rollins Facility in Deer Park, Texas was selected as the designated incineration facility.

The sequence of activities that would be performed in this alternative consist of the following:

- Evacuation of sediments for storm water concrete vaults
- Transportation of contaminated sediments to an off-site incineration facility
- Incineration
- Application of solidification agents to residual ash
- TCLP metals analysis
- Disposal of solidified ash

Protection of human health and the environment: This alternative provides protection for human health and the environment by providing a proven remedy that destroys the organic contaminants and successfully manages the remaining inorganics, providing a long-term permanent solution.

Compliance with ARARs: There are no chemical specific ARARs for the sediments in the concrete vaults. The sediment at the aircraft maintenance unit is isolated from the subsurface and groundwater by the concrete vault enclosures. The soil cleanup goal for TPH (10 mg/kg) for the protection of groundwater applies to sediments in the drainage channel. Remedial action objectives would be attainable by thermal destruction followed by solidification/stabilization.

Action specific ARARs that apply to off-site incineration followed by solidification/stabilization include excavation, air emissions, and Department of Transportation requirements. Additionally, the designated incineration facility will be responsible for fulfilling action specific ARARs that apply to their process. For the soil to be classified as a RCRA waste, the sediment contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste).

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: This alternative would result in complete destruction of TPH and benzo[a]pyrene contamination. The heavy metals contamination would be effectively managed by solidification/stabilization. The storm drain system would be sealed and isolated from water infiltration.

Reduction of toxicity, mobility, or volume through treatment: Off-site incineration would be effective in reducing the toxicity, mobility, or volume of the organic contaminants. The mobility of the heavy metal contamination would be reduced by solidification/stabilization.

Short-term effectiveness: Site workers may be exposed to contaminants during excavation and material handling. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Incineration would destroy organic contaminants and metals would be immobilized by solidification.

Implementability: Off-site incineration may be readily implemented as it is a proven technology, and it can be reliably operated. However, RCRA facility capacity may be limiting.

Cost: Remediation of the sediments in the concrete vaults involves removing the 10 cubic yards of sediment and treating. The estimated cost for this alternative and assumptions used are presented in Table D-7.2.4 in Appendix D. Capital costs are estimated to be $45,000. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable because this alternative would result in complete destruction of organic contaminants and management of the inorganics by controlling their mobility. However, the State would prefer on site treatment and disposal if possible.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk. However, the public would prefer not to transport hazardous material and instead treat and dispose of the soil on site if possible.

4.8 SITE 8: FUEL LINES

Two 8-inch and one 6-inch fuel line have been used to transport JP-4 and other fuels at HAA. TPH contaminant concentrations were detected above 10 mg/kg with a maximum of 264 mg/kg. TPH was detected in shallow soils (approximately 2 feet deep) at several locations along the fuel lines. They were found along the southern end of the 6-inch fuel line (1,330 cubic yards), and the additional fuel line north of the runway around eight fueling station boxes (1,850 cubic yards). Figure 1.10 shows the area of contamination that exceeds 10 mg/kg TPH along the fuel lines. Figure 4.23 is a map of TPH contamination at the Fuel Lines site. Lead concentrations were also measured, none of which exceeded the 535 mg/kg DTSC cleanup criteria. No other analytes were measured. The fuel lines have been combined with the UST removal project and has been assigned to Operable Unit 2. The alternative assessment discussed in this section is based on the EI results.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;
- S6: Excavation and Biological Treatment; and,
- S8: Excavation and Low Temperature Thermal Desorption.

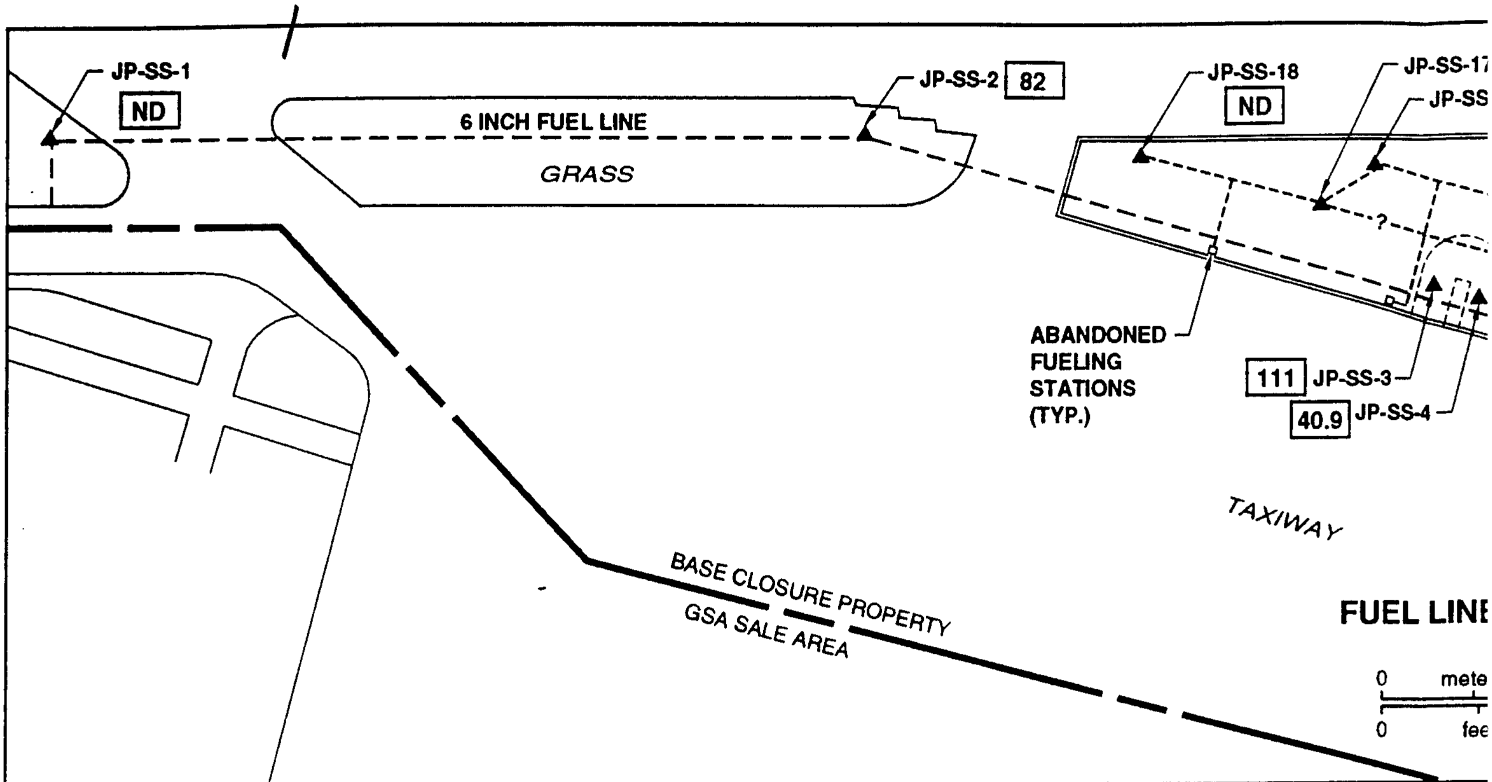
The following three sections present the evaluation for the three alternatives relative to the evaluation criteria. Additionally, Figure 4.24 presents the summary of the detailed analysis of the three remedial alternative retained relative to the evaluation criteria.

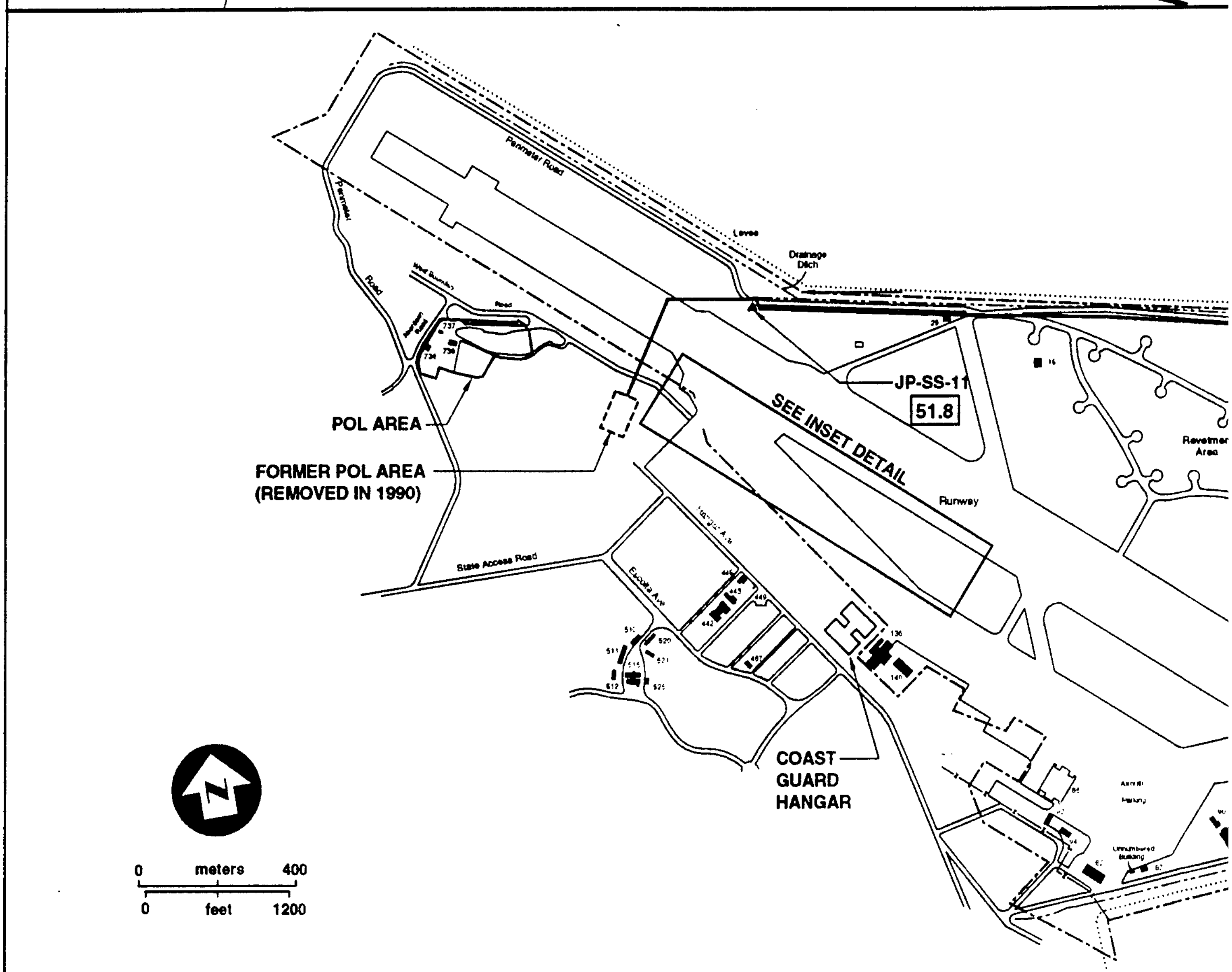
4.8.1 S1: No Action (Fuel Lines)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. To be cautious, land use restriction should be used to warn and limit receptors due to the unknown human health risk and low environmental risk for this alternative.

Protection of human health and the environment: For the no action alternative, the risk to human health can not be evaluated because the risk is not known. The risk to the environment is low (Engineering-Science 1993). The contamination may naturally degrade over time, however, this cannot be accurately predicted. The residual contaminants could also contaminate groundwater.

Compliance with ARARs: There are no chemical specific ARAR's for the detected analytes. However, a soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Lead concentrations do not exceed the 535 mg/kg, the calculated maximum acceptable inorganic lead level based on DTSC criteria. There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs (critical habitat/or and endangered or threatened species) apply





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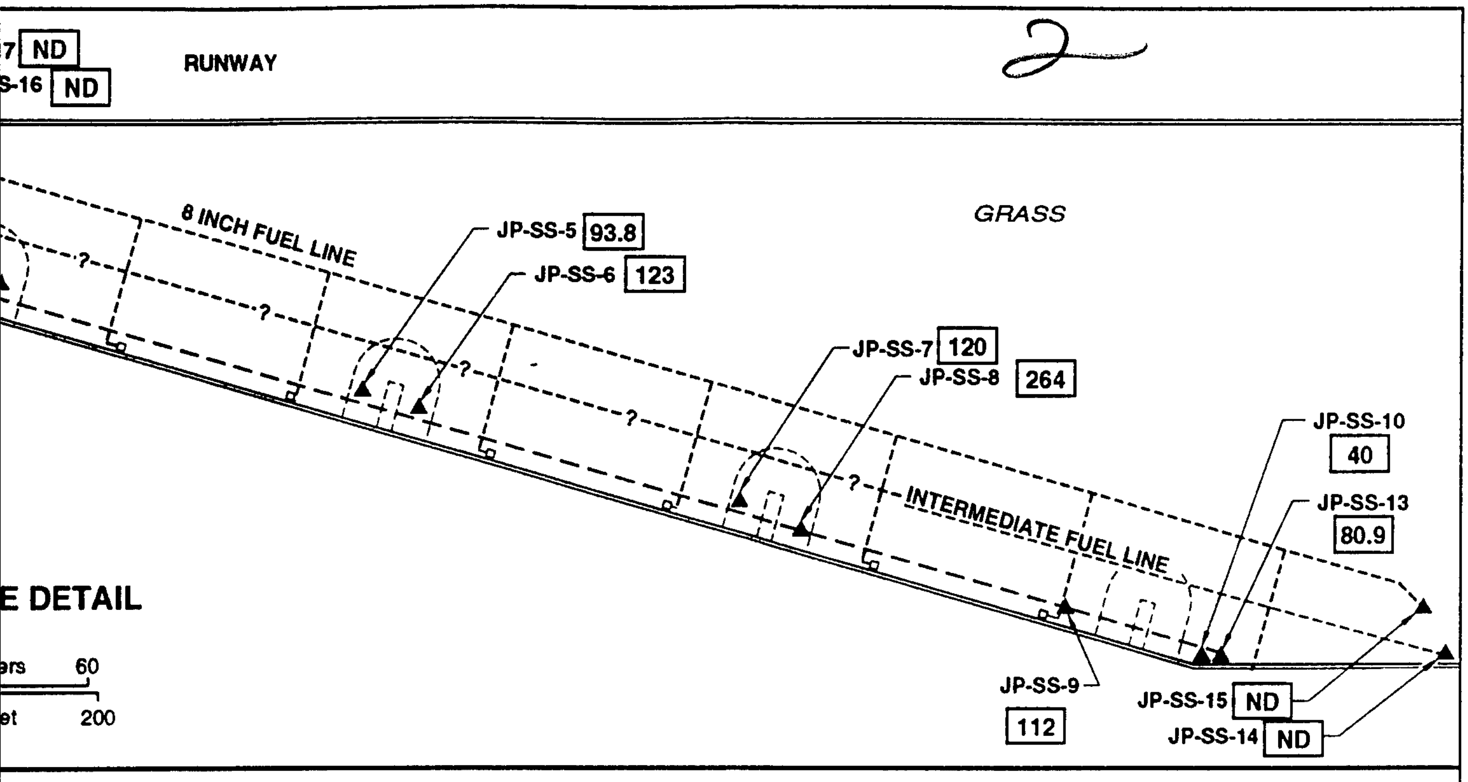

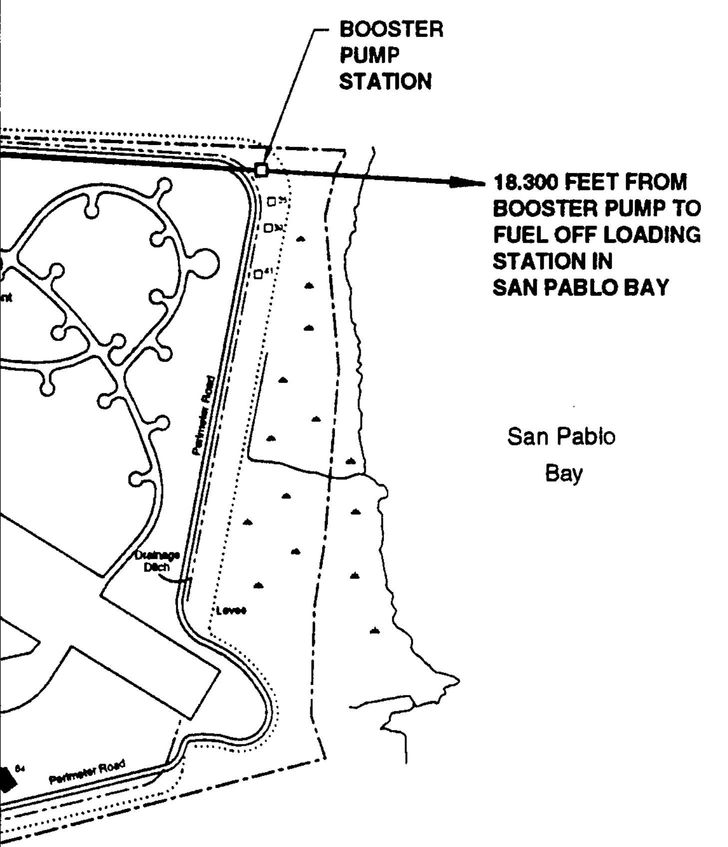

LEGEND

- BASE CLOSURE PROPERTY BOUNDARY
- DRAINAGE DITCH
- LEVEE
- JP-4 FUEL LINE
- 6-INCH FUEL LINE
- OTHER CONFIRMED FUEL LINES
- ABANDONED FUELING STATIONS
- SOIL SAMPLING LOCATIONS (SS)
- APPROX. LOCATION OF REMOVED AIRCRAFT FUELING TURNOUTS
- 82 TPH mg/kg
- ND NOT DETECTED

USATHAMA

Hamilton Army Airfield

FIGURE 4.23

FUEL LINES (OU1, OU2)
TPH CONCENTRATION IN SOIL

ENGINEERING-SCIENCE, INC.

FIGURE 4.24

Evaluation of Soil Remedial Alternatives

Site 8: Fuel Lines

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	◔	◑	◑	○	◕	◕	◔	◔	504,000
	S6: Excavation & Biotreatment (d)	◕	◕	◕	◕	◕	◕	●	●	171,000
	S8: Excavation & Thermal Desorption (d)	◕	◕	◕	◕	◑	◕	◕	◑	905,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Ground Water Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for the Area near TP-SD-1 which is only Contaminated with Metals. The Remaining Alternatives Address the PCB, DDD, DDE, Aldrin and Metals Contamination

at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (USACE 1990).

The no action alternative would not be in compliance with the soil cleanup goal because of the elevated TPH concentrations. Lead concentrations are well below a remedial action level (535 mg/kg). Location specific ARARs are not satisfied because there is a low expected risk for the present use land option to the burrowing owl (a listed endangered species), thus the no action alternative may affect the listed species.

Long-term effectiveness and permanence: The no action alternative is not directly effective in reducing residual TPH contamination. Furthermore, residual TPH contamination could impact the underlying groundwater. The contamination may naturally degrade over time, however, this cannot be accurately predicted.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative. Contaminants remaining in the soil could mitigate to the groundwater.

Implementability: This alternative is readily implemented technically, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The estimated cost for this alternative, based on a specific set of assumptions is presented in Table D-8.1. Capital costs of $31,000 are associated with the installation of one monitoring well, and implementing site restrictions. Annual costs of approximately $50,000 are associated with monitoring and maintenance, which account for present work costs of $504,000 assuming 30 years of operation and a 10 percent annual interest rate.

At present there are no wells near the fuel lines. Since the contamination near the fuel lines is shallow the regulatory agencies may consider not requiring groundwater monitoring. If groundwater monitoring is not required, the No Action alternative would be zero dollars ($0).

State acceptance: Regulatory acceptance may be difficult because this alternative would not achieve the TPH cleanup goal of 10 mg/kg through treatment.

Community acceptance: Community acceptance may also be difficult due to public perceptions regarding land use and lack of active treatment of contaminants.

4.8.2 S6: Excavation and Biological Treatment (Fuel Lines)

Biological treatment of contaminated soil has been proven effective for degrading TPHs. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit and either tilling the soil or drawing air through to aerate.

Nutrients or microorganisms could be added to enhance degradation. Typically degradation is assumed to take 6 to 18 months. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Soil sampling and analysis for TCLP RCRA metals
- Construction of the treatment unit (possibly including vent pipe and blower)
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or draw air through the pipe
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Backfilling and compaction of the excavation, and
- Regrading the site

Protection of human health and the environment: The potential risk to human health, the low risk to the environment resulting from the TPH contamination, and the potential migration of TPH contaminants to groundwater would be reduced because the TPH contamination source would be degraded.

Compliance with ARARs: There are no chemical specific ARAR's for the detected analytes. However, a soil cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Lead concentrations of soil left in place should not exceed 535 mg/kg, the calculated maximum acceptable inorganic lead level based on DTSC criteria. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. A pilot study is recommended to determine degradation rates. Lead contamination is already below 535 mg/kg.

Action specific ARARs that apply to bioremediation include excavation, stockpiling, compacting, and on-site soil replacement. All the action specific ARARs may be met with proper technology implementation. Because lead has been detected above background levels for this site, its leaching potential should be evaluated as per TCLP requirements and on-site disposal ARARs.

All the action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location specific ARARs would be satisfied with careful management.

Long-term effectiveness and permanence: Bioremediation would be protective in the long-term because most of the TPHs would be degraded in the soil, thus removing the potential groundwater contamination source. Furthermore, the lead contamination would be assessed as to its leaching potential and if metals management was needed, it would be added to fulfill ARAR requirements.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the TPH contaminants toxicity, mobility, and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Exposure to community during remediation is minimal. Treatment would remove source of contamination. Estimated remediation period is 2 years.

Implementability: Bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-8.2 in Appendix D. Capital costs are estimated to be $73,000 and are estimated to be $56,000 per year. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-8. The present worth cost is estimated to be $171,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable if the lead's leachable fraction is below RCRA hazardous waste requirements, or if the residual lead is managed such that ARARs are satisfied.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

4.8.3 S8: Excavation and Low Temperature Thermal Desorption (Fuel Lines)

Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments or sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800°F) can be adjusted to remove the TPH contaminants.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area if residual lead levels are sufficiently low. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Backfill and compaction of the excavation
- Regrade site, and
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: The potential risk to human health, the low risk to the environment resulting from the TPH contamination, and the potential migration of TPH contaminants to groundwater would be reduced because the TPH contamination source would be removed.

Compliance with ARARs: There are no chemical specific ARAR's for the detected analytes. However, a soil cleanup goal TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Lead concentrations should be less than 535 mg/kg, the calculated maximum acceptable inorganic lead level based on DTSC criteria. The lead contamination is already below 535 mg/kg. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, thermal desorption may not be able to remove all of the contamination. A treatability study is needed to confirm.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, on-site soil replacement, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location specific ARARs would be satisfied with careful management.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the TPHs would be removed from the soil, thus removing the potential groundwater contamination source. Furthermore, metals would be assessed as to their leaching potential and if metals management was needed it would be included to fulfill RCRA disposal requirements.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the TPH contaminants toxicity, mobility, and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emission must be monitored and controlled. Remediation period would be less than one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: The estimated cost for this alternative and assumptions used are presented in Table D-8.3 in Appendix D. Capital costs are estimated to be $905,000 and the project is estimated to take six months. It is assumed that groundwater monitoring would continue for 20 years and details pertaining to those costs are given in Table DWM-8. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable. Since thermal desorption has been shown to be effective in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be difficult because public perception regarding thermal treatment process.

4.9 SITE 9: BUILDING 442 AST

Building 442 the site of AST 11 which was used to store diesel fuel in the past, was investigated because fuel had been observed in the utility trench adjacent to the tank. A soil gas survey conducted during the EI found no detectable levels of BTEX in the soils. No TPH or BTEX contamination was found during Phase II of the EI. A recent investigation (H+GCL 1992) showed low levels of TPH (2.1 mg/kg) were found in the soil and xylene (0.5 µg/L) and ethylbenzene (0.6 µg/L) were found in groundwater. Although the groundwater is not regarded as a potable water source due to high TDS, the RWQCB has required confirmation groundwater sampling. Sampling is being undertaken by the USACE, Sacramento District. No analytes were identified which might impact the environment based on the ecological risk assessment (Engineering-Science 1993). The H+GCL data were not used for the ecological risk assessment.

Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) include:

- S1: No Action;

Figure 4.25 presents the summary of the detailed evaluation of the retained remedial alternative.

4.9.1 S1: No Action

The no action alternative was retained because no soil contamination was found at this site.

Protection of human health and the environment: No soil contamination was found, therefore, the no action alternative is protective of human health and the environment.

Compliance with ARARs: There are no chemical, action or location specific ARARs for this site.

Long-term effectiveness and permanence: The no action alternative provides long-term effectiveness and permanence for this site.

Reduction of toxicity, mobility, or volume through treatment: No contaminants were found at this site.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative.

Implementability: This alternative will be readily implemented.

Cost: The assumption used for estimating the cost for this alternative is presented in Table D-9.1 in Appendix D. As indicated, no capital, annual, or net present value costs are expected because no remedial actions are to be implemented.

State acceptance: Regulatory acceptance should be attainable.

Community acceptance: Community acceptance should be attainable

FIGURE 4.25

Evaluation of Soil Remedial Alternatives

Site 9: Building 442 AST

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Perman-ence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implement-ability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
NONE	S1: No Action	●	●	●	●	●	●	●	●	0

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars, No Groundwater Monitoring Assumed.

SECTION 5

DEVELOPMENT OPTION
EVALUATION OF GROUNDWATER REMEDIAL ALTERNATIVES

Six sites at Hamilton Army Airfield exceed groundwater ARARs and could potentially require groundwater remediation: the POL Area, Revetment Area, East Levee Landfill, Former Sewage Treatment Plant, Pump Station, and Aircraft Maintenance. Groundwater samples were not collected at or near the Fuel Lines. Groundwater from Bldg 442 showed one detection of TPH at the CRL (100 µg/L) in one round of sampling conducted by H+GCL (1992). Follow-up investigations by the Army Corps of Engineers, Sacramento District (USAEC 1993) using TPH analyses by modified Method 8015 did not confirm the presence of fuel hydrocarbons in groundwater. No surficial soil contamination was detected at Bldg. 442 (Engineering-Science 1993) but low levels of TPH were found in the subsurface soils (H+GCL 1992). No groundwater remedial action is recommended for both the Fuel Line Area and Bldg. 442 at this time. The no action alternative at the fuel line includes a one time calculation of free water from any remedial investigation.

The detailed analysis of groundwater remedial alternatives is based on the nine evaluation criteria established to address CERCLA requirements, the same criteria which were used to evaluate soil media remedial alternatives. Definitions of the evaluation criteria were provided in Section 4.0. In the remainder of this section, each of the retained alternatives is evaluated against the nine criteria to determine the performance of each alternative with respect to the criteria.

5.1 Site 1: POL Area

Within the POL Area, groundwater samples contain TPH concentrations as high as 14,000 µg/L, VOCs as high as 4,720 µg/L and semivolatile organic compounds at a maximum concentration of 1,474 µg/L. The VOCs consist primarily of aromatic hydrocarbons including benzene, toluene, ethylbenzene, xylene, and dimethylbenzene. The SVOCs include bis(2-ethylhexyl)phthalate, 2-methyl-naphthalene and naphthalene. Only two analytes exceeded their respective California MCLs of 1 µg/L and 4 µg/L, respectively: benzene (9.69 µg/L max.) and bis(2-ethylhexyl)phthalate (29.3 µg/L). TPH concentrations exceed the detection limit of 100 µg/L.

The water table in the vicinity of the POL Area is characterized in Section 1.1, and is dominated by a local area groundwater mound under the former location of AST-2 corresponding to the surface topography. The local depth to groundwater in the area near

AST-2 is estimated to be as much as 30 ft. The surface topography drops sharply north and west of the AST-2 location, and groundwater is much closer to the surface in other portions of the POL Area. Groundwater is inferred to flow radially outward from the former AST-2 location, principally to the northwest. Groundwater flow in the remainder of the POL Area is generally to the north.

Hydraulic tests on well MW-101, located less than 100 ft west of the former location of AST-2 indicate the water bearing soil zone to have a very low hydraulic conductivity value. The rate of contaminant migration has therefore been estimated to be quite slow, less than 6 feet per year (Engineering-Science 1993). No detectable concentrations of TPH, VOCs or SVOCs were detected in groundwater samples from well MW-103, located approximately 200 feet west-northwest of the former AST-2 location.

As stated in the risk assessment, the groundwater is brackish and has a low yield and is not considered a source of domestic water. Therefore, there are no current or future pathways associated with human exposure to groundwater (Engineering-Science 1993). Additionally, the risk assessment determined that movement of groundwater was so slow at the POL Area that little potential existed for it to interact with surface water. Therefore, the surface water pathway was considered insignificant and no risks to environmental receptors were identified. Pockets of fresh water have been identified for the Landfill 26 Area, located west of the POL Area, and existing or potential beneficial uses of groundwater at the Landfill 26 Area include industrial service supply and domestic water supply. Due to the proximity of the POL Area to the Landfill 26 Area, control or clean up of the POL Area groundwater is under consideration by regulators. Currently, no beneficial uses for POL Area groundwater have been identified. However the non-degradation policy of the SFRWQCB may require cleanup or control measures to be implemented.

At the POL Area, four of the initial seven groundwater remedial alternatives were retained for detailed analysis. The four alternatives retained at the POL Area for detailed analysis are:

- GW1: No Action
- GW2: In-situ Biostimulation
- GW4: Carbon Adsorption
- GW5: Biological Treatment

In the following sections, each of the POL Area groundwater alternatives will be assessed based on the nine evaluation criteria. The performance of each alternative is shown graphically in Figure 5.1

5.1.1 GW1: No Action (POL Area)

The no action alternative was retained for detailed analysis to provide a basis of comparison to other alternatives and to serve as a potentially viable alternative. The no action alternative for POL Site groundwater would include no remedial activities, but would include long-term groundwater monitoring. Groundwater monitoring would be

FIGURE 5.1

Evaluation of Groundwater Remedial Alternatives

Site 1: POL Area

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a, e)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH Benzene Bis2(e)	GW1: No Action	Low	Low	Low	No	Low	Moderate	Low	Low	562,000
	GW2: In-situ Biostimulation (d)	Low	Low	Low	Partial	Partial	Low	Low	Low	696,000
	GW4: Carbon Adsorption	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	676,000 176,000 (f)
	GW5: Biological Treatment	Partial	Low	Partial	Partial	Moderate	Partial	Partial	Partial	714,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Groundwater Monitoring.
Monitoring Costs for Remedial Alternatives are not Included

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) Bis2 = Bis(2-ethylhexl) Phthalate

(f) Transport to Landfill 26 Treatment Plant

REV. 8 C336-12.DWG 05/03/94

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conducted to evaluate contaminant migration over time. The monitoring period can be several years to indefinite time depending on the natural attenuation of the contaminants, however, for purposes of cost comparison, monitoring will be assumed to continue for a 30-year period, the design life of an EPA-funded remedial action. Every five years the results will be assessed, and an evaluation of the site risks identified. In addition land use restrictions may be considered.

For costing purposes, it is assumed that three additional wells would be installed around the former AST-2 location to verify the results of the initial investigation and augment the existing groundwater monitoring network at the POL Area.

Activities that would be conducted under the no action groundwater remedial alternative include:

- Annual groundwater sampling of the fifteen existing monitoring wells around the POL Area
- Assessment of site contaminants and risk evaluation every five years.

Protection of Human Health and the Environment: No groundwater remediation would take place under the no action alternative, and any risks identified to human health and the environment in the risk assessment would generally remain. No potential human or environmental receptors were identified for POL Area groundwater therefore no risks were identified (Engineering-Science 1993). The no action alternative is currently protective of human health and the environment based on these conclusions.

Compliance with ARARs: Potential federal chemical-specific ARARs identified for the POL Area include Safe Drinking Water Act MCLs and MCLGs, and Federal Ambient Water Quality Criteria for the protection of human health and aquatic life. Potential state chemical specific ARARs include the CalEPA MCLs and Applied Action Levels. The SFRWQCB non-degradation policy would require that TPH be remediated to non-detected concentrations. The CRL for TPH is 100 µg/L. State water quality goals are dependent on the beneficial uses for which the groundwater is protected. As stated previously, the beneficial uses of the site have not yet been determined, and no potential human or environmental receptors have been identified due to incomplete exposure pathways. Based on decisions made at Landfill 26, ARARs for groundwater at the POL area are likely to be drinking water standards (MCLs, both federal and state). The no action alternative does not reduce benzene, bis(2-ethylhexyl)phthalate or TPH concentrations.

There are no action-specific ARARs related to the no action alternative, although the State of California may have requirements for monitoring well installation.

Location-specific ARARs (critical habitat and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs do not apply to the no action alternative because the groundwater to surface water pathway is not considered complete, and does not affect endangered or threatened species.

Long-Term Effectiveness and Permanence: The no action alternative is effective in monitoring the migration of contaminants in site groundwater, but is not effective in reducing on-site groundwater contaminants. The no action alternative of groundwater monitoring affords no permanent solution to site contamination, although most contaminants would diminish by natural processes over a long period.

Reduction of Toxicity, Mobility or Volume Through Treatment: Under the no action alternative, no reduction of toxicity, mobility or volume of groundwater contaminants would occur. Long-term monitoring will allow a means to track the mobility of site contaminants however.

Short-Term Effectiveness: Because no activities would take place other than routine groundwater monitoring, the no action alternative would not involve any short-term impacts to the community, most site workers, or the environment. Personnel installing wells and collecting samples may contact groundwater, although impacts are considered negligible because of personnel training and the use of personal protective equipment. However, groundwater will continue to degrade and remedial objectives may not be met. The contamination plume would continue to migrate, degrading the downgradient water.

Implementability: The no action alternative would consist of annual monitoring for 30 years. Well monitoring is easily implemented, requires trained personnel which are readily available and standard equipment to collect samples for laboratory analysis.

Cost: The estimated cost for the no action alternative and the assumptions used are presented in Table DW-1.1 in Appendix D. Assumptions include monitoring a total of 15 wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital costs of $25,000 and annual costs are estimated at $57,000. The present worth cost assuming 10 percent interest is $562,000.

State Acceptance: Regulatory acceptance of the no action alternative is anticipated to meet some resistance because no remedial action is planned. However, since regulators will be involved in determining the beneficial use of the groundwater, the no action alternative may be acceptable if no beneficial use is designated.

Community Acceptance: Community acceptance may be difficult to achieve due to public perception regarding lack of remedial action.

5.1.2 GW2: In-Situ Biostimulation (POL Area)

In-situ biostimulation was retained primarily because it could be effective on the hydrocarbon contaminants at the POL Area and be cost effective. However, it was also considered somewhat difficult to control because of the low permeability of the soil.

In-situ biological treatment of groundwater uses the same principle as in-situ soil bioremediation (Section 4.1.3), and involves the stimulation of biological growth in contaminated groundwater in order to reduce the overall contaminant concentrations. The microorganisms consume and degrade hydrocarbon contaminants into acceptable breakdown products including fatty acids, carbon dioxide and water. Typically, microorganisms that are able to use some or all of the contaminants as substrata will already exist in small populations within the contaminated environment, and stimulation

of biological growth of these microorganisms will increase consumption of contaminants. Growth stimulation in aerobic environments is accomplished by addition of an oxygen source and essential nutrients and micronutrients. Success of this technology is highly dependent on soil permeability, which becomes the rate limiting step for mass transfer of oxygen to aerobic organisms. The treatment efficiency is measured in terms of contaminant reduction, use of dissolved oxygen, and bacterial growth. In-situ biostimulation has been applied to a number of hydrocarbon spills, and has been used to clean up methylene chloride and wood-treating chemicals. A schematic diagram of the process is included in Appendix E.

The most common oxygen source is dilute hydrogen peroxide injected under pressure in a water solution. This in-situ groundwater treatment alternative, as applied to the POL Area, includes construction of several injection wells or infiltration trenches in the contaminated area to allow nutrients, oxygen and if necessary, groundwater inoculated with acclimated bacteria to mix with POL Area groundwater. Construction of infiltration trenches into the zone of contaminated groundwater would increase the effectiveness of nutrient injection in the low permeability water bearing materials, but due to difficulty in constructing trenches to the 30 foot groundwater depth, trenches will not be evaluated in this alternative. The existing monitoring wells could be used to measure treatment efficiency.

For evaluation and costing purposes, activities that would be performed in this alternative are assumed to consist of the following:

- Installation of four injection wells within the area of contaminated groundwater, constructed to an estimated depth of 40 feet
- Installation of three additional monitoring wells to augment existing wells in contaminated groundwater area
- Injection of oxygen, nutrients and acclimated bacteria if necessary
- Monthly groundwater sampling from the existing wells in contaminated groundwater area for a period of five years

Protection of Human Health and the Environment: The in-situ biostimulation alternative is protective of human health and the environment because groundwater hydrocarbon and other organic contaminants will be degraded. No potential human or environmental receptors have been identified for POL Area groundwater. If future beneficial use of the groundwater is determined and cleanup is required, degradation of groundwater contaminants through in-situ biostimulation will reduce the potential risk associated with contaminated groundwater migration.

Compliance with ARARs: As described in the no action alternative, no chemical specific ARARs have been determined for the POL Area groundwater. MCLs may be used for comparison Biostimulation is capable of attaining ARARs for hydrocarbon contaminated groundwater under favorable site conditions. Concentrations of bis(2-ethylhexyl)phthalate will be reduced by biological treatment. However, typical percent removal ranges from 40 percent to 80 percent under ideal conditions, which is not

adequate to comply with the California MCL of 4 µg/L for bis(2-ethylhexyl)phalate (Patterson 1985). A treatability study would be required to determine what reduction in concentrations would be attainable for the POL Area groundwater contaminants given the low permeability soil matrix.

None of the potential action-specific ARARs listed in Table B-2 apply to the biostimulation of groundwater at the POL site. State of California requirements related to biostimulation would be met.

Location specific ARARs (critical habitat and endangered or threatened species) would be satisfied because the groundwater to surface water exposure pathway is not complete, and no exposures to the endangered species is anticipated. Engineering and site controls would be instituted during implementation of the biostimulation alternative to not disturb the endangered species or critical habitat.

Long-term effectiveness and permanence: TPH and other organic compounds in the groundwater would be degraded, thus minimizing the potential for contaminant migration or surface water interaction. However, in-situ biostimulation would not be completely protective in the long-term because bis(2-ethylhexyl)phthalate would still exceed ARARs.

Reduction of toxicity, mobility or volume through treatment: In-situ biostimulation would degrade POL Area contaminants in groundwater through treatment, and reduce the contaminant toxicity, mobility and volume of contaminated groundwater.

Short-term effectiveness: The in-situ biostimulation alternative involves no extraction and only limited direct contact with contaminated groundwater. Groundwater sample collection presents a minimal exposure potential to site workers. Implementation of proper procedures and use of personal protective equipment will minimize potential exposure to site workers and community. The plume would be contained and contaminants would be destroyed.

Implementability: Equipment needed to implement in-situ biostimulation is commercially available, and the technology has a reliable track record at sites with favorable conditions. Implementability at the POL Area is anticipated to be difficult however, due to the low permeability soils which limit transfer of oxygen to microorganisms. The length of time to achieve contaminant reduction is not known. For planning and costing purposes, a 5-year duration is assumed. A treatability study will be required to determine implementability.

Cost: The estimated cost for the in-situ biostimulation alternative and the assumptions used are presented in Table DW-1.2 in Appendix D. Assumptions include installing four injection wells, three additional monitoring wells and monitoring for 20 years. Capital costs of $169,000, annual costs are estimated at $56,000, and annual monitoring costs are $6,000. The present worth cost assuming 10 percent interest is $696,000.

State Acceptance: Regulatory acceptance may not be attainable because this technology is not sufficiently effective in treating bis(2-ethylhexyl)phthalate.

Community Acceptance: Community acceptance may not be attainable because this technology is not sufficiently effective in treating bis(2-ethylhexyl)phthalate.

5.1.3 GW4: Carbon Adsorption (POL Area)

Alternative GW4 includes the pumping of groundwater, pretreating it if necessary by filtration or precipitation, treating it through a carbon adsorption unit to remove hydrocarbon and volatile compounds, then discharging the treated effluent either as surface water or, to a POTW. A schematic of this process is shown in Appendix E. A variation of this alternative is to batch the extracted groundwater and transport by truck to the Landfill 26 Treatment Plant. The treatment plant consists of an oil/water separator, metal precipitation, sand filter, and carbon absorption. The design capacity of the treatment plant is 40 gpm which is sufficient to handle groundwater treatment at HAA. Since the flow rate at the POL contaminated area is 20 gallons per day, a batch size of 1,500 gallons could be transported every 75 days.

Groundwater may be pumped either through extraction wells and/or subsurface drains. Due to the low permeability soils at the site, daily pumping yield is estimated to be too low to provide constant flow to a treatment unit. Four extraction wells are included in order to contain the plume. Pumping units will transfer collected groundwater to an on-site treatment unit.

Filtration or chemical precipitation may be required as pretreatment measures to allow maximum contaminant removal efficiency in the carbon adsorption unit. Filtration is used to separate suspended matter from water or wastewater by passing it through a porous medium, such as sand. This process is useful for removing contaminants such as insoluble metals that are adsorbed to or absorbed by particulates, or to reduce turbidity. It is likely that the brackish groundwater characterized at the POL Area would require filtration prior to treatment with activated carbon.

Precipitation is the process of making dissolved chemical constituents insoluble so that they can be removed by sedimentation. It is typically used for removal of heavy metals or hardness-causing compounds from wastewater. Precipitation is usually accomplished by addition of alkalis or other precipitant to the liquid stream. This raises the pH and provides anions in the solution, resulting in a reduction in the solubility of the metals and the formation of a metal salt. Typical precipitating agents include calcium oxide, caustic soda, anhydrous ammonia, sodium sulfide, and ferrous sulfide. Frequently, the precipitates are flocculated into larger particles with the help of coagulants, such as alum, prior to sedimentation or filtration. The concentrations of heavy metals in groundwater samples collected from the POL Area are below MCLs and, therefore, chemical precipitation is not considered part of this alternative.

After filtration, groundwater will be treated through granular activated carbon (carbon). Carbon adsorption is used to remove dissolved organic and some insoluble inorganic compounds from contaminated water. It is effective on the low concentration volatile and semivolatile compounds detected at the POL Area. This process is based on the attraction of the organic molecules in solution to the surface of the activated carbon. The adsorption process is dependent on the strength of the molecular attraction between

the carbon and the organic contaminant, the molecular weight of the contaminant, the type and characteristics of the carbon, the surface area of the carbon, and the pH and temperature of the solution. After the carbon's surfaces become saturated with contaminants, the carbon is typically regenerated with heat, during which time the adsorbed organics are destroyed, or it can be replaced with fresh carbon.

Treated effluent from the carbon adsorption unit can be released as surface water or discharged to a POTW. Discharging treated water to surface water will likely require that a discharge permit be obtained through the NPDES, and analytical testing would be required to ensure that the effluent discharged is within the limits of the permit.

Treated water can also be discharged to the local POTW for processing or treatment. Usually, the POTW collects fees per gallon or pound of pollutant discharged to the POTW and establishes pretreatment requirements. Hazardous wastes cannot be discharged directly to the POTW unless pretreatment requirements have been met. POTWs are becoming increasingly sensitive to accepting effluent from environmental site cleanups, and the POTW will likely insist on a strict monitoring and oversight program, if they choose to accept the effluent at all. Discharge of treated effluent to the local POTW, Novato Sanitary Sewer District, is allowed only if no other alternatives are available.

For evaluation and costing purposes, activities that would be performed in this alternative are assumed to consist of the following:

- Installation of two subsurface drains and pumps;
- Installation of four extraction wells;
- Construction of on-site treatment unit consisting of sand filter and granular activated carbon column; and
- Effluent sampling prior to discharge.

Protection of Human Health and the Environment: Treatment of POL Area groundwater is protective of human health and the environment because contaminants are reduced through treatment. In addition, subsurface drains and extraction wells provide a barrier to the further migration of contaminated groundwater if properly constructed and operated. Analysis of treated effluent is conducted to ensure that pretreatment standards are met prior to discharge. Currently, no potential human or environmental receptors have been identified. If beneficial uses of groundwater are determined in the future, this treatment alternative will minimize future risk associated with migration of contaminated groundwater.

Compliance with ARARs: If the groundwater extraction process is successful, filtration and GAC adsorption is capable of treating POL Area groundwater contaminants to required pretreatment levels. By effectively extracting and treating contaminated groundwater, site contaminants will be reduced and potential chemical specific ARARs will be met.

With proper procedures, all action specific ARARs associated with groundwater extraction and treatment will be met. Action specific ARARs include pretreatment standards for reinjection, and proper handling of contaminated sand filter media and spent carbon. Pilot studies suggest typical removal rate of 18 percent to 66 percent for bis(2-ethylhexyl)phthalate (Patterson 1985), which is considered inefficient for large-scale remediation. In order to comply with discharge standards, significantly more carbon would be required relative to other systems at similar flow rates.

This alternative complies with location specific ARARs as no potential risk is identified to critical habitat or endangered species from this action. Care will be taken during implementation of the treatment activity to not disturb endangered species identified on site.

Long-term effectiveness and permanence: If groundwater extraction process is a success, treatment of groundwater provides a permanent and effective solution to groundwater contamination. The treatment of groundwater contaminants will minimize the potential for future risk associated with contaminant migration. Bis(2-ethylhexyl)phthalate has a very high affinity to the soil since the Freundrich sorption coefficient exceeds 11,000 mg/g (Patterson 1985). A pump and treat approach to remediation will likely take a very long time.

Reduction of toxicity, mobility or volume through treatment: Carbon adsorption will reduce the toxicity of on-site groundwater, reduce the possibility for contaminants to migrate, and reduce the volume of potentially contaminated groundwater. The volume of contaminated media will be reduced and consist only of contaminated sand filter media and spent carbon, both of which can be regenerated.

Short-term effectiveness: Implementation of this alternative presents very little potential for exposure to nearby communities, most site workers, and the environment. Site workers installing subsurface drains and extraction wells and treatment plant operators have minimal potential for exposure to site contaminants. Proper procedures and personal protective equipment will be used to minimize potential exposure to these personnel. The drawdown would contain the plume and the contaminants would be removed.

Implementability: Implementation of this alternative is anticipated to be difficult due to the low permeability soils on site and the large volume of carbon required. Based on estimated groundwater travel time of 6 feet per year and the required siting of subsurface drains at the toe of the former AST-2 hill, the ability to collect and treat low flows of contaminated groundwater may be difficult. Bis(2-ethylhexyl)phthalate has a high affinity to soil, and pump and treat methods will take a long time. The length of time required to collect and treat site contaminated ground may exceed 30 years.

Cost: The estimated cost for the carbon adsorption alternative and the assumptions used are presented in Table DW-1.3 in Appendix D. Assumptions include installing six extraction wells, and monitoring for 20 years. Capital costs are estimated to be $128,000, annual costs are estimated to be $9,000, and annual monitoring costs are $55,880. The present worth cost assuming 10 percent annual interest rate is $676,000.

If the groundwater is batched and transported to Landfill 26 for treatment, the annual cost is estimated at $13,000 and the present worth cost is $176,000.

State Acceptance: Regulatory acceptance should be attainable if the groundwater can be effectively extracted because the technology is proven in remediating groundwater contaminated with hydrocarbons and low level organic compounds.

Community Acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

5.1.4 GW5: Biological Treatment (POL Area)

Alternative GW5, biological treatment of POL Area groundwater involves pumping of contaminated groundwater to biological treatment units located on the surface. This alternative is similar in principle to the in-situ biostimulation alternative described in Section 4.1.2, but differs in that treatment does not occur in the subsurface. Biological treatment is capable of reducing the low concentration volatile and semivolatile compounds as well as petroleum hydrocarbons detected at the POL Area. Groundwater is pumped using either a series of extraction wells or subsurface drains, treated in a tank or other type of containment by mixing oxygen, nutrients, and acclimated bacteria into the water, and discharging treated effluent as surface water or to a POTW. A schematic of this alternative is shown in Appendix E.

Successful extraction of groundwater is primary to the implementability of this alternative. As described in the other alternatives, installation of several wells and subsurface drains would be required to extract groundwater. Wells only have an estimated yield of 150 gallons per day each. Subsurface trenches are preferred at the POL Area to increase the rate of groundwater extraction, but construction of trenches would have to be placed at the foot of the former AST-2 hill.

Biological treatment is likely to consist of holding tanks to allow the addition of nutrients and oxygen in a relatively controlled environment. In holding tanks, a rotating biological contractor constructed of polystyrene or polyvinyl chloride could be used to provide a support structure for the growth of microorganisms. Treatability studies would be required to determine what bacteria population can be attained, and the contaminant reduction it provides for petroleum hydrocarbons and the low concentration volatiles and semivolatiles in POL Area groundwater. After biodegradation is complete, effluent sampling would be conducted to ensure that contaminant reduction has been achieved, and the effluent will be discharged.

Treated effluent from the bioremediation unit can be released as surface water or discharged to a POTW. Discharging treated water to surface water will likely require that a discharge permit be obtained through the NPDES, and analytical testing would be required or alarms installed to ensure that the effluent discharged is within the limits of the permit.

Waste water can be discharged to the local POTW for processing or treatment. Usually, the POTW collects fees per gallon or pound of pollutant discharged to the

POTW. POTW establish pretreatment requirement for POTWs. Hazardous wastes cannot be discharged directly to the POTW unless pretreatment requirements have been met. Novato Sanitary Sewer District, the local POTW, prohibits discharge unless no other alternatives are available.

For planning and costing purposes, activities that would be performed in this alternative are assumed to consist of the following:

- Installation of two subsurface drains and pumps;
- Installation of four new extraction wells;
- Construction of on-site biological treatment unit consisting of several holding tanks for the addition of oxygen and nutrients to site groundwater; and
- Effluent sampling prior to discharge.

Protection of Human Health and the Environment: Biological treatment of POL Area groundwater is protective of human health and the environment because contaminants are reduced through treatment. In addition, proper construction of subsurface drains and extraction wells provide a barrier to minimize migration of contaminated groundwater. Analysis of treated effluent is conducted to ensure that pretreatment standards are met prior to discharge. Currently, no potential human or environmental receptors have been identified. If future beneficial uses of groundwater are determined and clean up is required, this treatment alternative will minimize potential risk associated with contaminated groundwater migration.

Compliance with ARARs: If the groundwater extraction process is successful, biological treatment can reduce most POL Area groundwater contaminants including bis(2-ethylhexyl)phthalate. However, typical percent removal ranges from 40 percent to 80 percent under ideal conditions, which would remediate to a concentration which is not enough to comply with California MCLs (Patterson 1985). Treatability studies would be required to verify the type of contaminant reduction attainable through biodegradation at the POL Area. Bis(2-ethylhexyl)phthalate has a very high affinity to the soil where the Freundrich sorption coefficient exceeds 11,000 mg/g (Patterson 1985). Remediation by pump and treat will likely require a very long time.

With proper procedures, action specific ARARs associated with groundwater extraction and biological treatment will be met. Action specific ARARs include pretreatment standards for discharge. It may not be possible to meet discharge requirements.

This alternative complies with location specific ARARs as no potential risk has been identified for critical habitat or endangered species from this action. Care will be taken during implementation of the treatment activity to not disturb endangered species identified on site.

Long-term effectiveness and permanence: If groundwater extraction process is successful, biological treatment of groundwater will provide a permanent and effective solution to groundwater contamination. The treatment of groundwater contaminants and

off-site discharge of effluent will minimize the potential for future risk associated with contaminant migration. Bis(2-ethylhexyl)phthalate has a very high affinity to the soil and as a result the pump and treat approach to remediation will likely take a very long time.

Reduction of toxicity, mobility or volume through treatment: Biological treatment will reduce the toxicity of on-site groundwater, reduce the possibility for contaminants to migrate, and reduce the currently existing volume of contaminated groundwater.

Short-term effectiveness: Implementation of this alternative presents minimal potential for exposure to nearby community, most site workers, and the environment. Site workers installing subsurface drains and extraction wells and biological treatment unit operators have minimal potential for exposure to site contaminants. Proper procedures and personal protective equipment will be used to minimize potential exposure to site workers. The drawdown would contain the plume and remove contaminants from the groundwater.

Implementability: Implementation of this alternative is anticipated to be difficult due to the low permeability soils on site. Based on estimated groundwater travel time of 6 feet per year and the required siting of subsurface drains at the toe of the former AST-2 hill, the ability to collect and treat low flows of contaminated groundwater may be difficult. Bis(2-ethylhexyl)phthalate has a high affinity to soil, and pump and treat methods will take a long time. The length of time required to collect and treat site contaminated ground may exceed 30 years. A treatability study must be conducted to determine the applicability of bioremediation on POL Area groundwater.

Cost: The estimated cost for the biological treatment alternative and the assumptions used are presented in Table DW-1.4 in Appendix D. Assumptions include installing six extraction wells and monitoring for 20 years. Capital costs are estimated to be $128,000, annual costs are estimated at $12,000, and monitoring costs are $57,000. The present worth cost assuming 10 percent interest $714,000.

State Acceptance: Regulatory acceptance may not be attainable since it may not be possible to meet discharge requirements for bis(2 ethylhexyl)phthalate.

Community Acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

5.2 SITE 2: BURN PIT

Three of five samples at the Burn Pit Site exceed the TPH detection limit of 100 µg/L. The maximum concentration among these samples was 140 mg/L. The remaining two samples were non-detect. These results are based on one round of sampling conducted in 1991 (Engineering-Science 1993). Additional sampling would be needed to determine if a trend exists. The source of groundwater contamination will likely be removed as part of the soils remediation discussed in Section 4. It is expected that the groundwater TPH concentration would diminish to below the CRL following removal of the contaminated soil.

As stated in the risk assessment, the groundwater is brackish has a low yield and is not considered a source of domestic water. There are no current or future pathways associated with human exposure to groundwater (Engineering-Science 1993). Additionally, the risk assessment determined that since movement of groundwater is extremely slow in these areas, little or no potential existed for the groundwater to interact with surface water. Therefore, the surface water pathway was considered incomplete and no risks to environmental receptors were identified. Currently, no beneficial uses for the groundwater at these sites have been identified. If site groundwater is determined in the future to have beneficial uses, clean up or control measures may have to be implemented.

The no action alternative is proposed for the Burn Pit Site. Figure 5.2 is a summary of the detailed analysis for the site.

5.2.1 GW1: No Action (Burn Pit)

The no action alternative was retained for detailed analysis to provide a basis of comparison to other alternatives and to serve as a potentially viable alternative. The no action alternative for groundwater would include no remedial activities, but would include long-term groundwater monitoring. Groundwater monitoring would be conducted to evaluate contaminant migration over time. The monitoring period can be several years to indefinite time depending on the natural attenuation of the contaminants, however, for purposes of cost comparison, monitoring will be assumed to continue for a 30-year period, the design life of an EPA-funded remedial action. Every five years the results will be assessed, and an evaluation of the site risks identified.

Activities that would be conducted under the no action groundwater remedial alternative include:

- Annual groundwater sampling at each of the four wells
- Assessment of site contaminants and risk evaluation every five years

A variation of the no action alternative is considered for the Burn Pit Site. It involves a one time collection of free water from any remedial excavation, no groundwater monitoring.

Protection of Human Health and the Environment: No groundwater remediation would take place under the no action alternative, and any risks to human health and the environment would generally remain. No potential human or environmental receptors

FIGURE 5.2

Evaluation of Groundwater Remedial Alternatives

Site 2: Burn Pit

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH	S1: No Action	Partial	Partial	Partial	No	Moderate	Moderate	Partial	Partial	1,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) No Action Assumes One Time Collection and Treatment of Contaminated Free Water from any Remedial Excavation and No Groundwater Monitoring.

REV.6 C336-13.DWG 06/03/94

were identified for the groundwater in the area, therefore no risks were identified (Engineering-Science 1993). The no action alternative is currently protective of human health and the environment based on these conclusions.

Compliance with ARARs: Potential federal chemical-specific ARARs identified for these sites include the Federal Ambient Water Quality Criteria for the protection of human health and saltwater aquatic life. TPH exceeds the CRL (100 mg/L) based on one round of sampling.

There are no action-specific ARARs related to the no action alternative.

Location-specific ARARs (critical habitat and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs do not apply to the no action alternative because the groundwater to surface water pathway is not considered complete, and does not affect endangered or threatened species.

Long-Term Effectiveness and Permanence: The no action alternative is effective in monitoring the migration of contaminants in site groundwater, but is not effective in reducing on-site groundwater contaminants. The no action alternative of groundwater monitoring affords no permanent solution to site contamination. However, contaminants would degrade overtime.

Reduction of Toxicity, Mobility or Volume Through Treatment: Under the no action alternative, no reduction of toxicity, mobility or volume of groundwater contaminants would occur. Long-term monitoring will allow a means to track the mobility of site contaminants however.

Short-Term Effectiveness: Because no activities would take place other than routine groundwater monitoring, the no action alternative would not involve any short-term impacts to the community, most site workers, or the environment. Personnel collecting samples may contact groundwater, although impacts are considered negligible because of personnel training and the use of personal protective equipment.

Implementability: The no action alternative would consist of annual monitoring for 30 years. If in the future additional monitoring wells are required, well installation and monitoring is easily implemented with common equipment, and requires trained personnel which are readily available and standard equipment to collect samples for laboratory analysis.

Cost: The estimated cost for the no action alternative is estimated on Table DW-2.1 in Appendix D. Assumptions made to estimate costs include annual sample collection from four existing wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital costs are estimated to be $17,000, and annual costs of $52,000 are associated with groundwater sample collection and analysis and net present value costs of $505,000 are estimated. Costs to re-evaluate health risks every five years are divided as an annual cost. Net present value costs assume a 30 year monitoring life and a 10 percent annual interest rate.

The cost for one-time collection of free water, no groundwater monitoring, is estimated to be $1,000. The cost to decommission the monitoring wells is included with the soil remedial alternatives.

State Acceptance: Regulatory acceptance of the no action alternative (30 years monitoring) is anticipated to meet some resistance because no remedial action is planned. However, since regulators will be involved in determining the beneficial use of the groundwater, the no action alternative may be acceptable if no beneficial use is designated. Regulators may accept the one-time collection of free water from the remedial excavation because the source of contamination to the groundwater is removed and treated.

Community Acceptance: Community acceptance may be difficult to achieve due to public perception regarding lack of remedial action. The community may accept the one-time collection of free water provided the source of contamination (the soil) is removed and treated.

5.3 SITE 3: REVETMENT AREA; SITE 4: PUMP STATION; AND SITE 6: EAST LEVEE LANDFILL

Manganese groundwater concentrations exceed the California secondary MCL (50 µg/L) at the Revetment Area, the Pump Station, and at the East Levee Landfill. The East Levee Landfill also has elevated levels of chloride and fluoride which also exceed secondary MCLs. The groundwaters in these areas are not considered potable and are naturally high in salts and minerals typical of sea water. The water in San Pablo Bay is relatively high in manganese and information is currently being collected by the SFRWQCB as part of a regional monitoring program. Water extracted from shallow sediment samples were approximately 4,400,000 µg/L manganese, (Taberski 1992). This is approximately the same order of magnitude as the maximum manganese concentration measured at these sites. Hence the secondary MCL for manganese may not be an appropriate ARAR for these sites.

The effects of manganese is discussed in the Toxicology profiles in Appendix H of the EI (Engineering-Science 1993). Manganese has a tendency to bioconcentrate in plants and small invertebrates. However, manganese has not been found to biomagnify in larger invertebrates and in fish.

As stated in the risk assessment, the groundwater is brackish, has a low yield, and is not considered a source of domestic water. There are no current or future pathways associated with human exposure to groundwater (Engineering-Science 1993). Additionally, the risk assessment in the EI determined that movement of groundwater is slow in these areas and that little or no potential existed for the groundwater to interact with surface water. Therefore, the surface water pathway was considered incomplete and no risks to environmental receptors were identified. Currently, no beneficial uses for the groundwater at these sites have been identified. If site groundwater is determined in the future to have beneficial uses, clean up or control measures may have to be implemented.

The no action alternative is proposed for all three sites. Figure 5.3 is a summary of the detailed analysis for all three sites.

5.3.1 GW1: No Action (Revetment, Pump Station, and East Levee Landfill)

The no action alternative was retained for detailed analysis to provide a basis of comparison to other alternatives and to serve as a potentially viable alternative. Monitoring would be conducted to determine if the groundwater is impacted by other contaminants. The no action alternative for groundwater at these sites would include no remedial activities, but would include long-term groundwater monitoring. Groundwater monitoring would be conducted to evaluate contaminant migration over time. Although HAA is not an NPL listed site, the cleanup is proceeding under CERCLA. The monitoring period can be several years to indefinite time depending on the natural attenuation of contaminants, however, for purposes of cost comparison, monitoring will be assumed to continue for a 30-year period, the design life of an EPA-funded remedial action. Every five years the results will be assessed, and an evaluation of the site risks identified. For planning and costing purposes, it is assumed that three additional wells

FIGURE 5.3

Evaluation of the No-Action Alternative at

Site 3: Revetment *Site 4: Pump Station* *Site 6: East Levee Landfill*

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost $
NONE	Site 3 Revetment (c)	◕	◕	◒	○	◕	◕	◕	◕	1,500
NONE	Site 4 Pump Station (d)	◕	◕	◒	○	◕	◕	◕	◕	2,500
NONE	Site 6 East Levee (e) Landfill	◕	◕	◒	○	◕	◕	◕	◕	7,500

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◒ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◒ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) No Action Alternative Includes Cost for Decommissioning of Well and No Groundwater Monitoring.

(d) One Time Collection and Treatment of Contaminated Free Water from Pump Station Tank Site Remedial Excavations, and No Groundwater Monitoring. Decommission Wells.

(e) No Monitoring is Required. Decommission Wells.

REV. 7 C336-14.DWG 05/06/94

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would be installed at the Revetment Area, one additional well at the Pump Station, and five new wells at the East Levee Landfill.

Activities that would be conducted under the no action groundwater remediation alternative include:

- Installation of monitoring wells
- Annual groundwater sampling at each site
- Assessment of site contaminants and risk evaluation every five years

A variation of the no action alternative is considered at all three sites. The Revetment and East Levee Landfill involve no groundwater monitoring and no collection of groundwater. Soil excavation and remediation at the Revetment Area would be included in this variation. No soil remedial activities are planned for East Levee Landfill. The no action alternative at the Pump Station includes soil excavation and remediation, a one-time collection of free water from the remedial excavation, and no groundwater monitoring.

Protection of Human Health and the Environment: No groundwater remediation would take place under the no action alternative, and any risks identified to human health and the environment in the risk assessment would generally remain. No potential human or environmental receptors were identified for the groundwater in the area, therefore no risks were identified (Engineering-Science 1993). The no action alternative is currently protective of human health and the environment based on these conclusions.

Compliance with ARARs: Potential federal chemical-specific ARARs identified for these sites include the Federal Ambient Water Quality Criteria for the protection of human health and saltwater aquatic life. Manganese, chloride, and fluoride levels at all three sites are less than the Federal Water Quality Criteria for saltwater, continuous exposure, and for human health for the consumption of aquatic organisms.

There are no action-specific ARARs related to the no action alternative.

Location-specific ARARs (critical habitat and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs do not apply to the no action alternative because the groundwater to surface water pathway is not considered complete, and does not affect endangered or threatened species.

Long-Term Effectiveness and Permanence: The no action alternative is protective of human health and the environment over the long term.

Reduction of Toxicity, Mobility or Volume Through Treatment: Under the no action alternative, no reduction of toxicity, mobility or volume of groundwater contaminants would occur.

Short-Term Effectiveness: Because no activities would take place the no action alternative would not involve any short-term impacts to the community, most site

workers, or the environment. Engineering controls would minimize exposure during collection of groundwater and soil excavation activities.

Implementability: The no action alternative is easily implemented.

Cost: The estimated cost for the no action at the Revetment Area alternative and the assumptions used are presented in Table DW-3.1 in Appendix D. Assumptions include monitoring a total of three wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital costs of $16,000 and annual costs are estimated at $51,000. The present worth cost assuming ten percent interest is $496,000. If the regulatory agencies agree to reduce the number of years of groundwater monitoring, then the cost for the no action alternative would be less. Agencies may consider not requiring monitoring if several successive monitoring events show no contamination is present. The cost for decommissioning the well and no monitoring at the Revetment Area would be $1,500.

The estimated cost for the no action at the Pump Station alternative and the assumptions used are presented in Table DW-4.1 in Appendix D. Assumptions include installing two additional monitoring wells and monitoring a total of three wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital costs of $38,420, and annual costs are estimated at $52,080. The present worth costs assuming ten percent interest is $529,400. The cost for one-time collection of free water from remedial excavations, decommissioning the well, and no groundwater monitoring would be $2,500.

The estimated cost for the no action at the East Levee Landfill alternative and the assumptions used are presented in Table DW-6.1 in Appendix D. Assumptions include monitoring a total of five wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital costs of $17,000, and annual costs are estimated at $52,800. The present worth cost assuming ten percent interest is $514,700.

The regulatory agencies recognize that the extent of TPH contamination of the East levee Landfill is small and relatively low. It may be possible to reduce the number of years required for groundwater monitoring. Agencies may consider eliminating the monitoring requirement if successive monitoring events show no contamination is present. For example, it only one year of monitoring is required the cost would be $17,000 plus the cost to close the wells. If no groundwater monitoring is conducted at East Levee Landfill and the five wells are decommissioned, the cost would be $7,500.

State Acceptance: Regulatory acceptance is likely since no primary MCLs are exceeded.

Community Acceptance: Community acceptance is likely since no health based MCLs (primary MCLs) are exceeded.

5.4 Site 5: Former Sewage Treatment Plant

As stated in the EI for the site, the groundwater at FSTP is brackish, has a low yield and is not considered a source of domestic water. There are no current or future pathways associated with human exposure to groundwater (Engineering-Science 1993).

Hydraulic tests on well MW-101, located less than 100 ft south of the former sludge drying beds indicate the water bearing soil zone to have a hydraulic conductivity of about 1.8×10^{-5} ft./sec. The rate of contaminant migration has therefore been estimated to be slow, approximately 550 feet per year (Engineering-Science 1993). Estimated extraction rate from a subsurface collection system is about 5 gpm.

Groundwater samples from the FSTP area contain VOC concentrations as high as 372 µg/L, semivolatile organic compounds at a concentration of 352 µg/L, and metals. The VOCs consist primarily of aromatic hydrocarbons including benzene, ethylbenzene, and xylene. The SVOCs detected include bis(2-ethylhexyl)phthalate, 2-methyl-naphthalene and naphthalene. Three organic compounds: benzene (1.24 µg/L max.), dichlorobenzene (DCB) at 15 µg/L max., and phenol (232 µg/L max.) exceeded their California MCLs of 1 µg/L, 5 µg/L and 5 µg/L, respectively. In addition, antimony and chloride concentrations exceed MCLs.

The groundwater at FSTP is very shallow (artesian) and a potential exists for groundwater to interact with surface water. Because of this potential pathway ecological risks to environmental receptors were identified. The only additional analyte in the groundwater that requires remediation based on the ecological risk is nickel.

Currently, no beneficial uses for FSTP groundwater have been identified. If site groundwater is determined in the future to have beneficial uses, clean up or control measures may have to be implemented.

Surface water present near AST 7 has been tested for VOCs, SVOCs, and metals. Two inorganic analytes, manganese and chloride, exceeded their respective secondary MCLs. Arsenic was identified as a potential analyte requiring remediation by the human health risk assessment. AST-7 is in fact located at the Pump Station Site. Surface water samples were collected at the same time FSTP samples were collected and this area was analyzed in the EI as being part of the FSTP. This area will be excavated as part of the soil remedial activities. One alternative considered is to collect the water that seeps into the excavation and treat. The excavation would remove the source of contamination.

The two groundwater treatment alternatives retained for detailed analysis are:

- GW1: No Action
- GW4: Precipitation followed by Carbon Adsorption

In the following sections, each of the FSTP Area groundwater alternatives will be assessed based on the nine evaluation criteria. The performance of each alternative is shown graphically in Figure 5.4. In situ biostimulation and biological treatment were not considered since dichlorobenzene is toxic to microorganisms (Patterson 1985).

FIGURE 5.4

Evaluation of Groundwater Remedial Alternatives

Site 5: Former Sewage Treatment Plant

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
Benzene, DCB, Phenol, Antimony	GW1: No Action (d)	◔	◔	◔	○	◕	◕	◔	◔	41,000
	GW4: Precipitation/ Carbon Adsorption	◕	◕	◕	◕	◑	◑	●	●	606,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars

(d) No Action Assumes Installing/Decommissioning Monitoring Wells, and One-Year Groundwater Monitoring. No Groundwater Remediation.

REV. 7 C336-15.DWG 05/06/94

ENGINEERING-SCIENCE, INC.

UV/oxidation is not effective in treating phenols and was not considered for treatment of FSTP groundwater (Patterson 1985).

5.4.1 GW1: No Action (FSTP)

The no action alternative was retained for detailed analysis to provide a basis of comparison to other alternatives and to serve as a potentially viable alternative. In the no action alternative, groundwater remedial activities would not be included, but would include long-term groundwater monitoring. Groundwater monitoring would be conducted to evaluate contaminant migration over time. The monitoring time could be several years to indefinite, time but for purposes of cost comparison, monitoring will be assumed to continue for a 30-year period. Every five years the results will be assessed, and an evaluation of the site risks identified.

Activities that would be conducted under the no action groundwater remedial alternative include:

- Installation of one monitoring well
- Annual groundwater sampling
- Assessment of site contaminants and risk evaluation every five years

A variation of the no action alternative is also considered. This alternative involves monitoring the existing well for one year and would be combined with one of the soil remedial technologies. If the results from monitoring are favorable, then groundwater monitoring will be discontinued and the well decommissioned.

Protection of Human Health and the Environment: No groundwater remediation would take place under the no action alternative, and any risks identified to human health and the environment in the risk assessment would generally remain. Since the potential exists that groundwater may connect with surface water, groundwater concentrations were compared with saltwater criteria for aquatic life. Nickel was the only chemical of concern in the groundwater for the protection of aquatic life. The groundwater in the area is brackish and not a potential drinking water source. No potential human receptors were identified for FSTP Area groundwater therefore no human health risks were identified (Engineering-Science 1993). The no action alternative is not protective of the environment based on these conclusions. However, if the source of contamination is removed as part of the soil remediation activities, the threat to the environment may be mitigated.

Compliance with ARARs: Potential federal chemical-specific ARARs identified for the FSTP Area include Safe Drinking Water Act MCLs and MCLGs, and Federal Ambient Water Quality Criteria for the protection of human health and saltwater aquatic life. Potential state chemical specific ARARs include the CalEPA MCLs and Applied Action Levels. State water quality goals are dependent on the beneficial uses for which the groundwater is protected. As stated previously, the groundwater at FSTP is brackish and not considered a potential drinking water source. However, the future beneficial uses of the site have not yet been determined.

The SFRWQCB has a nondegradation policy for the protection of groundwater. Although no human pathway for exposure has been identified, groundwater concentrations are to be compared with federal and California MCLs. In addition, groundwater must also comply with saltwater criteria for aquatic life. Compounds that exceed MCLs include benzene, dichlorobenzene, phenol, antimony, and chloride. Nickel exceeds the saltwater aquatic life criteria.

There are no action-specific ARARs related to the no action alternative, although the State of California may have requirements for monitoring well installations.

Location-specific ARARs (critical habitat and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990).

Long-Term Effectiveness and Permanence: The no action alternative is effective in monitoring the migration of contaminants in site groundwater, but is not effective in reducing on-site groundwater contaminants. The no action alternative of groundwater monitoring affords no permanent solution to site contamination. However, if the source of contamination is removed, the groundwater quality could be favorably affected.

Reduction of Toxicity, Mobility or Volume Through Treatment: Under the no action alternative, no reduction of toxicity, mobility or volume of groundwater contaminants would occur. Long-term monitoring will allow a means to track the mobility of site contaminants however.

Short-Term Effectiveness: Because no activities would take place other than routine groundwater monitoring, the no action alternative would not involve any short-term impacts to the community, most site workers, or the environment. However, groundwater will continue to degrade and remedial objective will not be met.

Implementability: The no action alternative is easily implemented. Annual monitoring would continue for 1 to 30 years.

Cost: The estimated cost for the no action alternative associated with the 30 years of monitoring and the assumptions used are presented in Table DW-5.1a in Appendix D. Assumptions include installing two additional monitoring wells and monitoring three wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital cost is estimated to be $39,000, and annual cost is estimated at $54,000. The present worth cost assuming 10 percent interest is $548,000.

The estimated cost for no action and only one year of monitoring is presented in Table DWM-5b in Appendix D. The capital cost is estimated to be $40,800. The present worth cost is the same as the capital cost.

State Acceptance: Regulatory acceptance of the no action alternative is anticipated to meet some resistance because no remedial action is planned. The no action alternative may be acceptable if no beneficial use of the groundwater is designated. The no action alternative may also be acceptable provided the source of contamination is removed as part of the soil remedial activities. Quarterly monitoring of the groundwater would either

confirm that the groundwater is no longer a threat or would serve as a basis for implementing groundwater remediation.

Community Acceptance: Community acceptance may be difficult to achieve due to public perception regarding lack of remedial action. However, if the source of contamination is removed as part of soil remedial activities, then no action for groundwater may be acceptable.

5.4.2 GW4: Precipitation Followed by Carbon Adsorption

Alternative GW4 includes the pumping of groundwater, pretreating it if necessary by filtration or precipitation, treating it through a carbon adsorption unit to remove hydrocarbon and VOCs, then discharging the treated effluent either as surface water or to a POTW. A schematic of this process is shown in Appendix E. The flow rate at the FSTP is too high to consider batching and transporting to Landfill 26 for treatment.

Groundwater may be collected in a long trench situated parallel to the slope and placed at the bottom of the hill. Flow rates for design purposes are estimated at 5 gpm, although no pump tests have been performed. Pumping units will transfer collected groundwater to an on-site treatment unit.

Chemical precipitation and filtration may be required as pretreatment measures to allow maximum contaminant removal efficiency in the carbon adsorption unit. Filtration is used to separate suspended matter from water or wastewater by passing it through a porous medium, such as sand. This process is useful for removing contaminants such as insoluble metals that are adsorbed to or absorbed by particulates, or to reduce turbidity. It is likely that the brackish groundwater characterized at the FSTP Area would require filtration prior to precipitation followed by treatment with activated carbon.

Precipitation is the process of making dissolved chemical constituents insoluble so that they can be removed by sedimentation. It is typically used for removal of heavy metals or hardness-causing compounds from wastewater. Precipitation is usually accomplished by addition of alkalis or other precipitants to the liquid stream. This raises then pH and provides anions in the solution, resulting in a reduction in the solubility of the metals and the formation of a metal salt. Typical precipitating agents include calcium oxide, caustic soda, anhydrous ammonia, sodium sulfide, and ferrous sulfide. Frequently, the precipitates are flocculated into larger particles with the help of coagulants, such as alum, prior to sedimentation or filtration. Due to the high concentrations of metals in groundwater samples collected from the FSTP Area, chemical precipitation is considered part of this alternative.

After filtration, groundwater will be treated through a column of granular activated carbon. Carbon adsorption is used to remove dissolved organic and some insoluble inorganic compounds from contaminated water. It is effective on the low concentration volatile and semivolatile compounds detected at the FSTP Area. This process is based on the attraction of the organic molecules in solution to the surface of the activated carbon. The adsorption process is dependent on the strength of the molecular attraction between the carbon and the organic contaminant, the molecular weight of the contaminant, the type and characteristics of the carbon, the surface area of the carbon, and the pH and

temperature of the solution. After the carbon's surfaces become saturated with contaminants, the carbon is typically regenerated with heat, during which time the adsorbed organics are destroyed, or it can be replaced with fresh carbon.

Treated effluent from the carbon adsorption unit can be released as surface water or discharged to a POTW. Discharging treated water to surface water will likely require that a discharge permit be obtained through the NPDES, and analytical testing would be required to ensure that the effluent discharged is within the limits of the permit.

Treated water can also be discharged to the local POTW for processing or treatment. Usually, the POTW collects fees per gallon or pound of pollutant sent to the POTW and establishes pretreatment requirements. Hazardous wastes cannot be discharged directly to the POTW unless pretreatment requirements have been met. POTWs are becoming increasingly sensitive to accepting effluent from environmental site cleanups, and the POTW will likely insist on a strict monitoring and oversight program, if they choose to accept the effluent at all. Discharge of treated effluent to the local POTW, Novato Sanitary Sewer District, is allowed only if no other alternatives are available.

For evaluation and costing purposes, activities that would be performed in this alternative are assumed to consist of the following:

- Installation of a long collector trench at base of slope and pumps
- Construction of on-site treatment unit consisting of sand filter, precipitation unit, clarifier, granular activated carbon column, and a filter press for dewatering the precipitate
- Effluent sampling prior to discharge

Protection of Human Health and the Environment: Treatment of FSTP Area groundwater is protective of human health and the environment because contaminants are reduced through treatment. In addition, subsurface drains provide a barrier to the further migration of contaminated groundwater if properly constructed and operated. Analysis of treated effluent is conducted to ensure that pretreatment standards are met prior to discharge. If beneficial uses of groundwater are determined in the future, this treatment alternative will minimize future risk associated with migration of contaminated groundwater.

Compliance with ARARs: If the groundwater extraction process is successful, precipitation followed by carbon adsorption is capable of treating organic groundwater contaminants to required pretreatment levels (Patterson 1985). By effectively extracting and treating contaminated groundwater, site contaminants will be reduced and potential chemical specific ARARs will be met. This alternative, however, is not likely to reduce chlorides to MCLs. Dechlorination of saltwater may require distillation, reverse osmosis, or electrodialysis as post treatment after carbon adsorption. Dechlorination is not considered as part of this alternative.

With proper procedures, all action specific ARARs associated with groundwater extraction and treatment will be met. Action specific ARARs include organic pretreatment standards for discharge, and proper handling of contaminated sand filter

media, filter cake, and spent carbon. This alternative would not meet effluent standards for chlorides or fluorides. These requirements may require compliance to RCRA waste levels if the filter cake is determined to be RCRA waste. For the filter cake to be classified as a RCRA waste, the filter cake contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the filter cake is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Care will be taken during implementation of the treatment activity to not disturb endangered species identified on site and to comply with location specific ARARs.

Long-term effectiveness and permanence: If the groundwater extraction process is successful, treatment of groundwater provides a permanent and effective solution to groundwater contamination. The treatment of groundwater contaminants will minimize the potential for future risk associated with contaminant migration.

Reduction of toxicity, mobility or volume through treatment: Precipitation followed by GAC adsorption will reduce the toxicity of on-site groundwater, reduce the possibility for contaminants to migrate, and reduce the volume of potentially contaminated groundwater. The volume of contaminated media will be reduced and consist of contaminated sand filter media and spent carbon, both of which can be regenerated, and also the filter cake containing metal oxides.

Short-term effectiveness: Implementation of this alternative presents minimal potential for exposure to nearby communities, most site workers, and the environment. Site workers installing subsurface drains and treatment plant operators have minimal potential for exposure to site contaminants. Proper procedures and personal protective equipment will be used to minimize potential exposure to these personnel. The collector trench would contain the plume and the contaminants would be removed.

Implementability: Implementation of this alternative is anticipated to be difficult due to the low permeability soils on site. In addition, the length of time required to collect and treat site contaminated ground may be quite lengthy, estimated at 30 years.

Cost: The estimated cost for the precipitation followed by carbon adsorption alternative and the assumptions used are presented in Table DW-5.2 in Appendix D. Assumptions include installing a 250-foot collector trench, and monitoring for 20 years. Capital costs are estimated to be $51,000, annual costs are estimated to $11,000 and monitoring costs are $54,000. The present worth cost assuming 10 percent interest is $606,000.

State Acceptance: Regulatory acceptance should be attainable because the technology is proven in remediating groundwater contaminated with low concentrations of organic compounds.

Community Acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

5.5 Site 7: Aircraft Maintenance Area

Three of the analytes detected at the Aircraft Maintenance Area include benzene (1.16 μg/L), beryllium (20 μg/L) and chromium (52.4 μg/L) exceeded their EPA or California MCL values of 1 μg/L, 4 μg/L, and 50 μg/L, respectively. Manganese (3,650 μg/L) exceeded its secondary MCL value of 50 μg/L. No additional analytes were identified by the ecological risk assessment.

As stated in the risk assessment of the EI, the groundwater is brackish, has a low yield, and is not considered a source of domestic water. Therefore, there are no current or future pathways associated with human exposure to groundwater (Engineering-Science 1993). Additionally, the risk assessment determined that movement of groundwater was so slow at the Aircraft Maintenance Area that little or no potential existed for it to interact with surface water. The pathway of groundwater to surface water was considered to be only intermittently complete during the winter rainy season and during periods of flooding and, therefore, would not have significant risks. During these occasional events, infiltrating surface water percolates through contaminated soil and may interact with groundwater and discharge to the perimeter ditch. Based on hydraulic conductivity values, the groundwater contribution to the total flow in the ditch is considered to be minor. Therefore, beneficial use of groundwater to replenish surface water is questionable. If the site groundwater is determined in the future to have beneficial uses, cleanup or control measures may have to be implemented.

The ground surface is relatively flat throughout the area, and local depth to groundwater ranges from approximately 4.8 feet bgs, in AM-MW-103, to approximately 5.5 feet bgs in AM-MW-104. Groundwater is estimated to flow from north to south in this area, toward the perimeter drainage ditch. Hydraulic tests on well MW-101, located less than 100 feet west of the former location of the above ground storage area, indicate the water bearing soil zone to have a low hydraulic conductivity value ranging from 1 x 10-5 to 8.5 x 10^{-7} ft/sec.. The rate of contaminant migration has therefore been estimated to be slow, less than 315 feet per year (Engineering-Science 1993).

The four alternatives retained at the Aircraft Maintenance Area for detailed analysis are:

- GW1: No Action
- GW4: Precipitation followed by Carbon Adsorption
- GW5: Precipitation followed by Biological Treatment
- GW6: Precipitation followed by Ultraviolet-Ozone Oxidation

In the following sections, each of the Aircraft Maintenance Area groundwater alternatives will be assessed based on the nine evaluation criteria. In situ biostimulation was not considered because of anticipated interference by metals in the groundwater. The performance of each alternative is shown graphically in Figure 5.5.

FIGURE 5.5

Evaluation of Groundwater Remedial Alternatives

Site 7: Aircraft Maintenance Area

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
Benzene Beryllium Chromium	GW1: No Action	Partial	Low	Low	No	Moderate	Moderate	Partial	Partial	525,000
	GW4: Precipitation followed by Carbon Adsorption	Moderate	Moderate	Partial	Moderate	Partial	Partial	High	High	641,000 323,000 (f)
	GW5: Precipitation followed by Biological Treatment (d)	Moderate	Moderate	Partial	Moderate	Moderate	Partial	High	High	641,000
	GW6: Precipitation followed by UV/Ozone Oxidation	Moderate	Moderate	Partial	Moderate	Moderate	Partial	High	High	877,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes 30 Years of Groundwater Monitoring.
Monitoring Costs for Remedial Alternatives are not Included.

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(f) Transport to Landfill 26 Treatment plant

5.5.1 GW1: No Action (Aircraft Maintenance)

The no action alternative was retained for detailed analysis to provide a basis of comparison to other alternatives and to serve as a potentially viable alternative. The no action alternative for Aircraft Maintenance Area groundwater would include no remedial activities, but would include long-term groundwater monitoring. Groundwater monitoring would be conducted to evaluate contaminant migration over time. The monitoring period can be several years to indefinite time depending on the natural attenuation of the contaminants, however, for purposes of cost comparison, monitoring will be assumed to continue for a 30-year period, the design life of an EPA-funded remedial action. Every five years the results will be assessed, and an evaluation of the site risks identified.

Activities that would be conducted under the no action groundwater remedial alternative include:

- Annual groundwater sampling
- Assessment of site contaminants and risk evaluation every five years.

Protection of Human Health and the Environment: No groundwater remediation would take place under the no action alternative, and any risks identified to human health and the environment in the risk assessment would generally remain but reduce over time due to natural attenuation. No potential human or environmental receptors were identified for Aircraft Maintenance Area groundwater therefore no risks were identified (Engineering-Science 1993). The no action alternative is currently protective of human health and the environment based on these conclusions.

Compliance with ARARs: Potential federal chemical-specific ARARs identified for the Aircraft Maintenance Area include Safe Drinking Water Act MCLs and MCLGs, and Federal Ambient Water Quality Criteria for the protection of human health and saltwater aquatic life. Potential state chemical specific ARARs include the CalEPA MCLs and Applied Action Levels. State water quality goals are dependent on the beneficial uses for which the groundwater is protected. As stated previously, the beneficial uses of the site have not yet been determined, and no potential human or environmental receptors have been identified due to incomplete exposure pathways. The SFRWQCB has a nondegradational policy for the protection of groundwater. Although no human pathway for exposure has been identified, groundwater concentrations are compared with federal and California MCLs. Analyses that exceed MCLs include benzene, beryllium, chromium, and manganese.

There are no action-specific ARARs related to the no action alternative, although the State of California may have requirements for monitoring well installations if needed in the future.

Location-specific ARARs (critical habitat and endangered or threatened species) apply at HAA because plant and animal species currently listed as endangered or threatened under state or federal endangered species act are described as occurring or potentially occurring at or near HAA (Corps 1990). Location specific ARARs do not apply to the no

action alternative because the groundwater to surface water pathway is not considered complete, and does not affect endangered or threatened species.

Long-Term Effectiveness and Permanence: The no action alternative is effective in monitoring the migration of contaminants in site groundwater, but is not effective in reducing on-site groundwater contaminants. The no action alternative of groundwater monitoring affords no permanent solution to site contamination.

Reduction of Toxicity, Mobility or Volume Through Treatment: Under the no action alternative, no reduction of toxicity, mobility or volume of groundwater contaminants would occur. Long-term monitoring will allow a means to track the mobility of site contaminants however.

Short-Term Effectiveness: Because no activities would take place other than routine groundwater monitoring, the no action alternative would not involve any short-term impacts to the community, most site workers, or the environment. However, groundwater may continue to degrade and the remedial objective may not be meet. The contamination plume would continue to migrate, degrading the downgradient water.

Implementability: The no action alternative is easily implemented, requiring trained personnel who are readily available, and standard equipment to collect samples for laboratory analysis. Annual monitoring would continue for 30 years.

Cost: The estimated cost for the no action alternative and the assumptions used are presented in Table DW-7.1 in Appendix D. Assumptions include monitoring a total of four wells for 30 years. Every five years an assessment will be made to reassess the site contaminants and potential risks. Capital costs are estimated to be $25,000, and annual costs are estimated at $53,000. The present worth cost assuming ten percent interest is $525,000.

State Acceptance: Regulatory acceptance of the no action alternative is anticipated to meet some resistance because no remedial action is planned. However, since regulators will be involved in determining the beneficial use of the groundwater, the no action alternative may be acceptable if no beneficial use is designated.

Community Acceptance: Community acceptance may be difficult to achieve due to public perception regarding lack of remedial action.

5.5.2 GW4: Precipitation Followed by Carbon Adsorption (Aircraft Maintenance)

Alternative GW4 includes the pumping of groundwater or using passive collection trenches pretreating the groundwater, if necessary, by filtration or precipitation, treating it through a carbon adsorption unit to remove hydrocarbon and VOCs, then discharging the treated effluent either as surface water, to a POTW, or reinjecting it into groundwater. A schematic of this process is shown in Appendix E. A variation of this alternative is to batch the extracted groundwater and transport by truck to the Landfill 26 Treatment Plant. The treatment plant consists of an oil/water separator, metal precipitation, sand filter, and carbon absorption. The design capacity of the treatment plant is 40 gpm which is sufficient to handle groundwater treatment at HAA. It the flow rate at the Aircraft

Maintenance contaminated area is 0.1 gpm, a batch size of 5,000 gallons could be transported every 34 days.

Groundwater may be pumped either through extraction wells or collected in subsurface drains. Due to the low permeability soils at the site, daily pumping yield is estimated to be too low to provide constant flow to a treatment unit. The yield in a passive collection trench could be even less. Pumping units will transfer collected groundwater to an on-site treatment unit.

Chemical precipitation and filtration may be required as pretreatment measures to allow maximum contaminant removal efficiency in the carbon adsorption unit. Filtration is used to separated suspended matter from water or wastewater by passing it through a porous medium, such as sand. This process is useful for removing contaminants such as insoluble metals that are adsorbed to or absorbed by particulates, or to reduce turbidity. It is likely that the brackish groundwater characterized at the Aircraft Maintenance Area would require filtration prior to treatment with activated carbon.

Precipitation is the process of making dissolved chemical constituents insoluble so that they can be removed by sedimentation. It is typically used for removal of heavy metals or hardness-causing compounds from wastewater. Precipitation is usually accomplished by addition of alkalis or other precipitants to the liquid stream. This raises then pH and provides anions in the solution, resulting in a reduction in the solubility of the metals and the formation of a metal salt. Typical precipitating agents include calcium oxide, caustic soda, anhydrous ammonia, sodium sulfide, and ferrous sulfide. Frequently, the precipitates are flocculated into larger particles with the help of coagulants, such as alum, prior to sedimentation or filtration. Due to the high concentrations of metals in groundwater samples collected from the Aircraft Maintenance Area, chemical precipitation is considered part of this alternative.

After filtration, groundwater will be treated through a column of granular activated carbon. Carbon adsorption is used to remove dissolved organic and some inorganic compounds from contaminated water. It is effective on the low concentration volatile and semivolatile compounds detected at the Aircraft Maintenance Area. This process is based on the attraction of the organic molecules in solution to the surface of the activated carbon. The adsorption process is dependent on the strength of the molecular attraction between the carbon and the organic contaminant, the molecular weight of the contaminant, the type and characteristics of the carbon, the surface area of the carbon, and the pH and temperature of the solution. After the carbon's surfaces become saturated with contaminants, the carbon is typically regenerated with heat, during which time the adsorbed organics are destroyed, or it can be replaced with fresh carbon.

Treated effluent from the carbon adsorption unit can be released as surface water or discharged to a POTW. Discharging treated water to surface water will likely require that a discharge permit be obtained through the NPDES, and analytical testing would be required or alarms installed to ensure that the effluent discharged is within the limits of the permit.

Treated water can be discharged to the local POTW for processing or treatment. Usually, the POTW collects fees per gallon or pound of pollutant and establishes pretreatment requirements. Hazardous wastes cannot be discharged directly to the POTW unless pretreatment requirements have been met. POTWs are becoming increasingly sensitive to accepting effluent from environmental site cleanups, and the POTW will likely insist on a strict monitoring and oversight program, if they choose to accept the effluent at all. Discharge of treated effluent to the local POTW, Novato Sanitary Sewer District, is allowed only if no other alternatives are available.

For evaluation and costing purposes, activities that would be performed in this alternative are assumed to consist of the following:

- Installation of a passive groundwater collection trench
- Construction of on-site treatment unit consisting of a filter, precipitation unit, clarifier, and granular activated carbon column and a filter press for dewatering the precipitate
- Effluent sampling prior to discharge

Protection of Human Health and the Environment: Extraction and treatment of Aircraft Maintenance Area groundwater is protective of human health and the environment because contaminants are reduced through treatment. In addition, subsurface drains provide a barrier to the further migration of contaminated groundwater if properly constructed and operated. Analysis of treated effluent is conducted to ensure that pretreatment standards are met prior to discharge. Currently, no potential human or environmental receptors have been identified. If beneficial uses of groundwater are determined in the future, this treatment alternative will minimize future risk associated with migration of contaminated groundwater.

Compliance with ARARs: If the groundwater extraction process is successful, precipitation followed by GAC adsorption is capable of treating Aircraft Maintenance Area groundwater contaminants to required pretreatment levels. By effectively extracting and treating contaminated groundwater, site contaminants will be reduced and potential chemical specific ARARs will be met.

With proper procedures, all action specific ARARs associated with groundwater extraction and treatment will be met. Action specific ARARs include pretreatment standards for discharge, and proper handling of contaminated sand filter media, filter cake, and spent carbon. These requirements may require compliance to RCRA waste levels if the filter cake is determined to be RCRA waste. For the filter cake to be classified as a RCRA waste, the filter cake contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the filter cake is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative complies with location specific ARARs as no potential risk is identified to critical habitat or endangered species from this action. Care will be taken

during implementation of the treatment activity to not disturb endangered species identified on site.

Long-term effectiveness and permanence: If the groundwater extraction process is successful, treatment of groundwater provides a permanent and effective solution to groundwater contamination. The treatment of groundwater contaminants will minimize the potential for future risk associated with contaminant migration.

Reduction of toxicity, mobility or volume through treatment: Precipitation followed by GAC adsorption will reduce the toxicity of on-site groundwater, reduce the possibility for contaminants to migrate, and reduce the volume of potentially contaminated groundwater. The volume of contaminated media will be reduced and consist of contaminated sand filter media and spent carbon, both of which can be regenerated, and also filter cake containing metals.

Short-term effectiveness: Implementation of this alternative presents minimal potential for exposure to nearby community, most site workers, and the environment. Site workers installing subsurface drains and treatment plant operators have minimal potential for exposure to site contaminants. Proper procedures and personal protective equipment will be used to minimize potential exposure to these personnel. Extraction, if effective would contain the plume and the contaminants would be removed.

Implementability: Implementation of this alternative is anticipated to be difficult due to the low permeability soils on site. In addition, the length of time required to collect and treat site contaminated groundwater may be quite lengthy, estimated at 30 years.

Cost: The estimated cost for the carbon adsorption alternative and the assumptions used are presented in Table DW-7.2 in Appendix D. Assumptions include installing a collection trench and monitoring for 20 years. Capital costs are estimated to be $112,00, annual costs are estimated at $9,000, and monitoring costs are $53,000. The present worth cost assuming ten percent interest is $641,000.

If the groundwater is batched and transported to Landfill 26 for treatment, the annual cost is estimated at $29,000 and the present worth cost over 20 years is $323,000.

State Acceptance: Regulatory acceptance should be attainable because the technology is proven in remediating groundwater contaminated with hydrocarbons and low level organic compounds.

Community Acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

5.5.3 GW5: Precipitation Followed by Biological Treatment (Aircraft Maintenance)

Alternative GW5, biological treatment of Aircraft Maintenance Area groundwater involves pumping of contaminated groundwater to biological treatment units located on the surface. Biological treatment is capable of reducing the low concentration of volatile compounds such as benzene. Groundwater is pumped using either a series of extraction wells or subsurface drains, treated in a tank or other type of containment by mixing

oxygen, nutrients, and acclimated bacteria into the water, and discharging treated effluent as surface water, to a POTW, or reinjecting it back into the ground. A schematic of this alternative is shown in Appendix E.

Successful extraction of groundwater is primary to the implementability of this alternative. Groundwater may be pumped either through extraction wells or collected in subsurface drains. Due to the low permeability soils at the site, daily pumping yield is estimated to be too low to provide constant flow to a treatment unit. The yield in a passive collection trench could be even less. Pumping units will transfer collected groundwater to an on-site treatment unit. If the flow rate at Aircraft Maintenance is 0.1 gpm, a batch size of 5,000 gallons could be transported every 34 days.

Chemical precipitation and filtration may be required as pretreatment measures to allow maximum contaminant removal efficiency in the biological treatment unit. Filtration is used to separated suspended matter from water or wastewater by passing it through a porous medium, such as sand. This process is useful for removing contaminants such as insoluble metals that are adsorbed to or absorbed by particulates, or to reduce turbidity. It is likely that the brackish groundwater characterized at the Aircraft Maintenance Area would require filtration prior to treatment with activated carbon.

Biological treatment is likely to consist of holding tanks to allow the addition of nutrients and oxygen in a relatively controlled environment. In holding tanks, a rotating biological contractor constructed of polystyrene or polyvinyl chloride could be used to provide a support structure for the growth of microorganisms. Treatability studies would be required to determine what bacteria population can be attained, and the contaminant reduction it provides for the low concentration VOCs in Aircraft Maintenance Area groundwater. After biodegradation is complete, effluent sampling would be conducted to ensure that contaminant reduction has been achieved, and the effluent will be discharged.

Treated effluent from the bioremediation unit can be released as surface water or discharged to a POTW. Discharging treated water to surface water will likely require that a discharge permit be obtained through the NPDES, and analytical testing would be required or alarms installed to ensure that the effluent discharged is within the limits of the permit.

Treated water can also be discharged to the local POTW for processing or treatment. Usually, the POTW collects fees per gallon or pound of pollutant and establishes pretreatment requirements. Hazardous wastes cannot be discharged directly to the POTW unless pretreatment requirements have been met. Novato Sanitary Sewer District, the local POTW, prohibits discharge unless no other alternatives are available.

For planning and costing purposes, activities that would be performed in this alternative are assumed to consist of the following:

- Installation of a passive groundwater collection trench
- Construction of on-site treatment consisting of a filter, precipitation unit, clarifier, and biological treatment unit consisting of several holding tanks for the addition of oxygen and nutrients to site groundwater

- Effluent sampling prior to discharge.

Protection of Human Health and the Environment: Precipitation followed by biological treatment of Aircraft Maintenance Area groundwater is protective of human health and the environment because contaminants are reduced through treatment. In addition, proper construction of subsurface drains provide a barrier to minimize migration of contaminated groundwater. Analysis of treated effluent is conducted to ensure that pretreatment standards are met prior to discharge. Currently, no potential human or environmental receptors have been identified. If future beneficial uses of groundwater are determined and groundwater cleanup is required, this treatment alternative will minimize potential risk associated with contaminated groundwater migration.

Compliance with ARARs: If the groundwater extraction process is successful, biological treatment has the capability of treating the organic groundwater contaminants to ARARs. Treatability studies would be required to verify the type of contaminant reduction attainable through biodegradation at the Aircraft Maintenance Area. By effectively extracting and treating contaminated groundwater, site contaminants will be reduced and chemical specific ARARs will be met.

With proper procedures, all action specific ARARs associated with groundwater extraction and biological treatment will be met. Action specific ARARs include pretreatment standards for discharge. These requirements may require compliance to RCRA waste levels if the filter cake is determined to be RCRA waste. For the filter cake to be classified as a RCRA waste, the filter cake contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the filter cake is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative complies with location specific ARARs as no potential risk is identified to critical habitat or endangered species from this action. Care will be taken during implementation of the treatment activity to not disturb endangered species identified on site.

Long-term effectiveness and permanence: If groundwater extraction process is successful, precipitation followed by biological treatment of groundwater will provide a permanent and effective solution to groundwater contamination. The treatment of groundwater contaminants and off-site discharge of effluent will minimize the potential for future risk associated with contaminant migration.

Reduction of toxicity, mobility or volume through treatment: Precipitation followed by biological treatment will reduce the toxicity of on-site groundwater, reduce the possibility for contaminants to migrate, and reduce the currently existing volume of contaminated groundwater.

Short-term effectiveness: Implementation of this alternative presents minimal potential for exposure to nearby community, most site workers, and the environment. Site workers installing subsurface drains and biological treatment unit operators have minimal potential for exposure to site contaminants. Proper procedures and personal

protective equipment will be used to minimize potential exposure to site workers. The drawdown would contain the plume and remove contaminants from the groundwater.

Implementability: Implementation of this alternative is anticipated to be difficult due to the low permeability soils on site. In addition, the length of time required to collect and treat site contaminated ground may be quite lengthy, estimated at 30 years. A treatability study must be conducted to determine the applicability of extraction, precipitation and bioremediation on Aircraft Maintenance Area groundwater.

Cost: The estimated cost for the bioremediation alternative and the assumptions used are presented in Table DW-7.3 in appendix D. Assumptions include installing a collection trench and monitoring for 20 years. Capital costs are estimated to be $120,000, annual costs are estimated at $8,000, and monitoring costs are $53,000. The present worth costs assuming ten percent interest is $641,000.

State Acceptance: Regulatory acceptance should be attainable provided that results from a treatability study is favorable.

Community Acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

5.5.4 GW6: Precipitation Followed by Ultraviolet-ozone Oxidation (Aircraft Maintenance)

This oxidation alternative utilizes ultraviolet (UV) radiation in combination with ozone to catalyze the chemical oxidation process. This form of treatment is accomplished by contacting the ozone with the contaminated water in a closed reactor in the presence of ultraviolet light. UV radiation causes destruction or weakening of the chemical bond in the organic compounds, which are then more easily oxidized by ozonation. Ozone alone has the ability to break down some organics, but has generally been shown to be an ineffective oxidant of halogenated organics under conditions normally used for disinfecting wastewater. The ozone is applied by bubbling it through the water being treated. The combination of UV and ozone treatment makes it possible to oxidize compounds that would not be oxidized by ozone treatment only. A schematic of this treatment alternative is shown in Appendix E.

Chemical precipitation and filtration may be required as pretreatment measures to allow maximum contaminant removal efficiency in the oxidation unit. Filtration is used to separated suspended matter from water or wastewater by passing it through a porous medium, such as sand. This process is useful for removing contaminants such as insoluble metals that are adsorbed to or absorbed by particulates, or to reduce turbidity. It is likely that the brackish groundwater characterized at the Aircraft Maintenance Area would require filtration prior to treatment.

Activities that would be conducted under the ultraviolet-ozone oxidation alternative include:

- Installation of a groundwater collection trench

- Construction of on-site treatment unit consisting of a filter, precipitation unit, clarifier, and an above ground UV-ozone oxidation treatment unit
- Effluent sampling prior to discharge.

Protection of Human Health and the Environment: UV/ozone oxidation is effective for destroying most compounds at the Aircraft Maintenance Area. However, the process may result in production of by-products that may require further treatment. UV/ozone oxidation is protective of human health and the environment because contaminants are reduced through treatment. Treatability studies would be required to determine what by-products may be generated from this process, and to ensure human health and the environment are protected. Analysis of treated effluent is conducted to ensure that pretreatment standards are met prior to discharge. Currently, no potential human or environmental receptors have been identified. If future beneficial uses of groundwater are determined and cleanup is required, this treatment alternative will minimize future risk associated with contaminated groundwater migration.

Compliance with ARARs: If the groundwater extraction process is successful, UV-ozone oxidation has the capability of destroying a wide range of organic compounds, including many of those found in Aircraft Maintenance Area groundwater. Incomplete oxidation will generate other organic compounds that may require further evaluation and possibly treatment. This oxidation process has been used at similar sites for removing VOCs.

With proper procedures, all action specific ARARs associated with groundwater extraction and UV-ozone oxidation will be met. Action specific ARARs include pretreatment standards for discharge and proper identification and treatment of process by-products. These ARARs may require compliance to RCRA waste levels if the filter cake is determined to be RCRA waste. For the filter cake to be classified as a RCRA waste, the filter cake contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the filter cake is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative complies with location specific ARARs as no potential risk is identified to critical habitat or endangered species from this action. Care will be taken during implementation of the treatment activity to not disturb endangered species identified on site.

Long-term effectiveness and permanence: If groundwater extraction process is successful, precipitation followed by UV/ozone treatment of groundwater could provide a permanent and effective solution to groundwater contamination. The extraction and treatment of groundwater contaminants and off-site discharge of effluent will minimize the potential for future risk associated with contaminant migration.

Reduction of toxicity, mobility or volume through treatment: Construction of subsurface drains, treatment and discharge of treated groundwater will reduce the toxicity of on-site groundwater, reduce the possibility for contaminants to migrate, and reduce the currently existing volume of potentially contaminated groundwater.

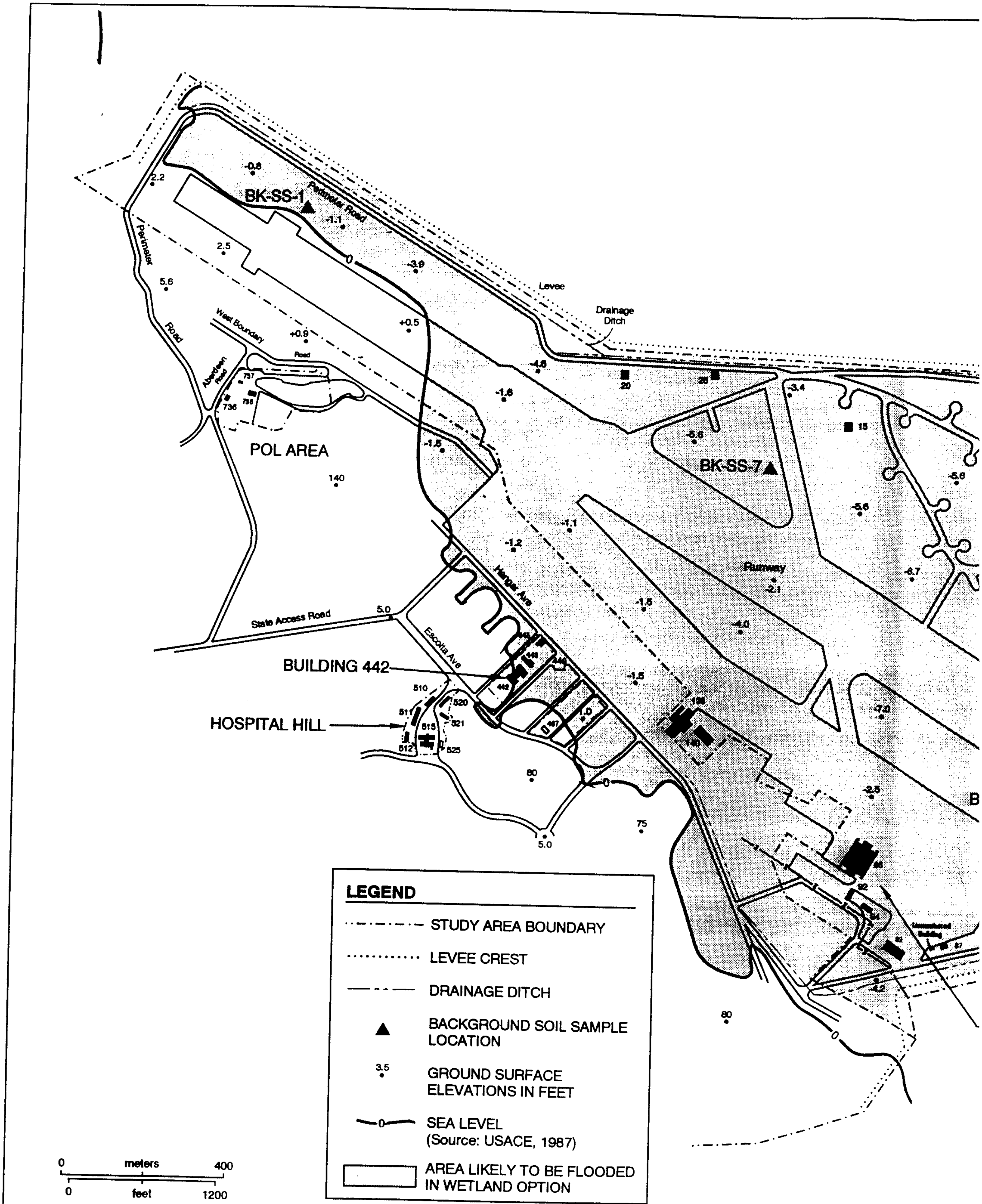
Short-term effectiveness: Implementation of this alternative presents minimal potential for exposure to the nearby community, most site workers, and the environment. Site workers installing subsurface drains and UV/ozone oxidation treatment unit operators have minimal potential for exposure to site contaminants. Proper procedures and personal protective equipment will be used to minimize potential exposure to site workers.

Implementability: Implementation of this alternative is anticipated to be difficult due to the low permeability soils on site. The length of time required to collect and treat site contaminated ground may be quite lengthy, estimated at 30 years.

Cost: The estimated cost for the UV/ozone oxidation alternative and the assumptions used are presented in Table DW-7.4 in Appendix D. Assumptions include installing a groundwater collection trench and monitoring for 20 years. Capital costs are estimated to be $248,000, annual costs are estimated at $21,000, and monitoring costs are $53,000. The present worth cost assuming ten percent interest is $877,000.

State Acceptance: Regulatory acceptance should be attainable. The generation of other organic compounds or by-products would have to be addressed to the regulators satisfaction.

Community Acceptance: Community acceptance should be attainable. Public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.



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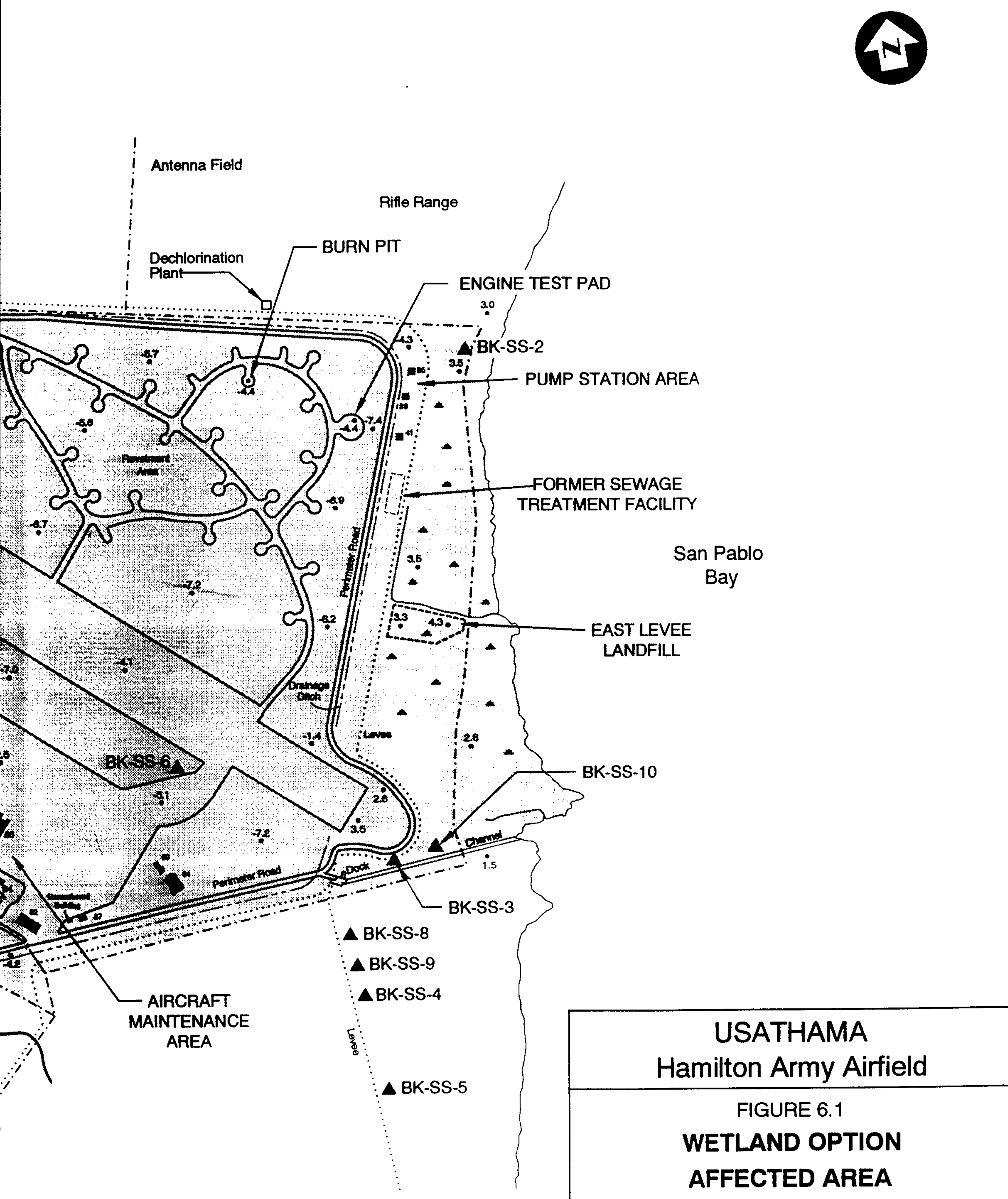

USATHAMA
Hamilton Army Airfield

FIGURE 6.1
WETLAND OPTION AFFECTED AREA

ENGINEERING-SCIENCE, INC.

TABLE 6.1

RETAINED REMEDIAL ALTERNATIVES FOR DETAIL EVALUATION
WETLAND OPTION

Site and Media of Concern	Alternatives Retained for Detailed Evaluation
Site 1: POL Area	
Soil Groundwater	Not affected by wetland reuse. See Table 3.4 (Development Option)
Site 2: Burn Pit	
Soil	S1, S2/S6, S2/S8
Site 3: Revetment Area	
Soil	S1, S2/S6, S2/S8
Site 4: Pump Station	
AST-5, stockpile soil	S1, S2/S6, S2/S8
AST-7 soil	S1, S2/S6/S7, S2/S7/S8
Sediments and AST-6	S1, S2/S7/S9, S2/S7/S11, S2/S12
Site 5: Former Sewage Treatment Plant	
Soil	S1, S2/S7/S9, S2/S7/S11, S2/S12
Site 6: East Levee Landfill	
Soil	S1, S2/S6/S7, S2/S8/S7
Site 7: Aircraft Maintenance and Storage Area	
Soil	S1, S2/S6/S7, S2/S8/S7
Sediments	S1, S2/S6/S7, SS2/S8/S7, S2/S9/S7
Site 8: Fuel Lines	
Soil	S1, S2/S6/S7, S2/S8/S7
Site 9: Building 442 AST	
Soil	Not affected by wetland reuse. See Table 3.4 (Development Option)
Site 10: Transformer and Other Oil Filled Items	NA

Legend:

S1-No Action
S2-Capping
S3-In-situ Soil Flushing
S4-In-situ Bioremediation
S5-In-situ Soil Vapor Extraction
S6-Biological Treatment
S7-Solidification/Stabilization
S8-Low Temp. Desorption
S9-Thermal Destruction
S10-In-situ Bioventing
S11-Chemical Oxidation
S12-Soil Washing

The following three sections present the evaluation for these alternatives to the nine evaluation criteria. Additionally, Figure 6.2 presents a summary of the detailed analysis of the remedial alternatives retained relative to the evaluation criteria.

6.2.1 S1: No Action (Burn Pit, Revetment).

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place.

Protection of human health and the environment: No risk to the environment was identified in the risk assessment for the no action alternative (Engineering-Science 1993). The contamination may naturally degrade over time, however, the time cannot be accurately predicted.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Location specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: The no action alternative is not directly effective in reducing residual contamination. The contamination may naturally degrade over time, however, this cannot be accurately predicted with available data.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative does not directly reduce the toxicity, mobility, or volume of contaminants through treatment. Eventually most contaminants would diminish.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative.

Implementability: Technically this alternative is readily implemented, because no action is required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: If there is no groundwater monitoring and no soils treatment, then there would be no costs associated with the no action alternative. A variation of the no action alternative is considered at the Burn Pit site. This would involve a one-time collection of free water from any remedial excavation. The cost to collect and treat the groundwater is $1,000. The cost is kept separate in order to be easily combined with soil remedial alternatives in Section 7, Conclusions. This alternative assumes soil remediation will take place.

State acceptance: Regulatory acceptance may be difficult because this alternative would not achieve the TPH cleanup goal of 100 mg/kg through treatment. Regulatory acceptance may be attainable because the contamination may naturally degrade over time, however, the time cannot be accurately predicted.

Community acceptance: Community acceptance may be difficult to obtain due to public perceptions, regarding land use and lack of active treatment of contaminants.

FIGURE 6.2

Evaluation of Soil Remedial Alternatives Wetland Option

Site 2: Burn Pit and Site 3: Revetment

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (f) $
TPH	S1: No Action	◑	◔	◔	○	●	◕	◑	◔	BP: 1,000 (c) RV: 0 (d)
	S2/S6: Excav. & Biological Treatment, Capping (e)	◕	◕	◕	◕	◕	◕	●	●	BP: 217,000 RV: 1,593,000
	S2/S8: Excav. & Thermal Desorption, Capping (e)	◕	◕	◕	◕	◑	◕	◕	◑	BP: 716,000 RV: 5,324,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

● High level of compliance
◕ Moderate level of compliance
◑ Partial level of compliance
◔ Low level of compliance
○ No level of compliance

(b) Level of Acceptance

● High level of acceptance
◕ Moderate level of acceptance
◑ Partial level of acceptance
◔ Low level of acceptance
○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes No Groundwater Monitoring,
One Time Collection of Free Water from Remedial Excavation at Burn Pit

(d) No Action Assumes No Groundwater Monitoring.

(e) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(f) BP: Burn Pit
RV: Revetment

6.2.2 S2/S6: Excavation, Capping and Biological Treatment (Burn Pit, Revetment Area).

Biological treatment of contaminated soil has been proven effective for degrading TPH. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit. The soil is aerated either mechanically by tilling the soil or passively through a vent pipe placed in the soil pile. Since the flow rate is very low, emissions control would not be necessary. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade the contaminants in the soil. Nutrients or special microorganisms can also be added to enhance the remediation process. The areas exceeding 10 mg/kg TPH would then be covered with fill material. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed upon implementation of this alternative consist of the following:

- Construction of the treatment unit (possibly including vent pipe and blower)
- Excavation of contaminated soils exceeding 100 mg/kg TPH and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or drawing air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Apply 3 feet of non-engineered fill to soils exceeding 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: No risk to the environment was identified in the risk assessment (Engineering-Science 1993).

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained.

There are no locations specific ARARs for the Wetland Option.

All the action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, applying cover pit on-site, and placement of treated soil. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to a be RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are

treated with a specific treatment technology or until constituent concentrations are reduced below specific levels.

Long-term effectiveness and permanence: Bioremediation would be protective in the long-term because most of the TPH would be degraded in the soil. Covering the soil contaminated with TPH (above 10 mg/kg) would be protective because the cover would serve as a substrate for plant life and would act as a barrier to exposure to biota.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the toxicity, mobility, and volume of the TPH contamination.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Remedial objectives could be achieved in approximately two years.

Implementability: Bioremediation followed by covering areas with fill is readily implemented as there are proven technologies, components are commercially available, and it can be reliably operated.

Cost: Remediation of soils contaminated with TPH greater than 100 mg/kg at the Burn Pit involve excavating and treating 3,390 cubic yards of soil. Approximately 1,960 cubic yards of cover material 3 feet high would be applied to the area contaminated with TPH exceeding 10 mg/kg. The estimated cost for this alternative and the assumption used are presented in Table DF-2.2. The capital cost is estimated to be $118,000 and the annual colts are estimated to be $57,000 per year. The present worth cost is estimated to be $217,000 assuming a two year project life and ten percent annual interest rate.

Remediation of soils contaminated with TPH greater than 100 mg/kg at the Revetment involved excavating and treating 23,500 cubic yards of soil. Approximately 77,260 cubic yards of cover material 3 feet high would be applied to the area contaminated with TPH exceeding 10 mg/kg. The estimated cost for this alternative and the assumptions used are presented in Table DF-3.2. The capital cost is estimated to be $938,000 and the annual costs are estimated to be $377,000 per year. The present worth cost is estimated to be $1,593,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contamination in soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

6.2.3 S2/S8: Excavation, Capping and Low Temperature Thermal Desorption (Burn Pit, Revetment)

Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments, and sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the

contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800° F) can be adjusted to remove TPHs, VOCs, or SVOCs.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense the organic compounds and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal. The areas exceeding 10 mg/kg TPH would then be covered with fill material.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils exceeding 100 mg/TPH and transport to storage pad
- Screening all material larger than 2 inches from soil
- Shredding material larger than 2 inches
- Conveying soils to processing system
- Transferring treated soil to storage pad for temporary storage
- Sampling treated soil to monitor contaminant removal
- Apply 3 feet of non-engineered fill the soils exceeding 10 mg/kg TPH
- Regrade site
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: No risk to the environment was identified by the risk assessment (Engineering-Science 1993).

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. Applying 3 feet of cover material satisfies the sediment criteria for nickel at Aircraft Maintenance.

Action specific ARARs that apply to low temperature thermal desorption include excavation, stockpiling, compacting, air emissions, applying cover fill on-site, and placement of treated soil. All action specific ARARs may be met with proper technology implementation.

Location specific ARARs do not apply for the Wetland Option.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, on site replacement of treated soil, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are treated with a specific technology or until constituents concentrations are reduced below specific levels.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the TPH would be removed from the soil. Covering the soil with TPH (above 10 mg/kg) would serve as a substrate for plant life and would act as a barrier to exposure to biota.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the toxicity, mobility, and volume of the TPH contamination.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emissions must be monitored and controlled. Remedial objective could be achieved in approximately one year.

Implementability: Low temperature thermal desorption followed by covering areas with fill is readily implemented since they are proven technologies, components are commercially available, and thermal desorption can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: Remediation of soils contaminated with TPH at the Burn Pit involves excavating and treating 3,390 cubic yards of soil. Approximately 1,960 cubic yards of cover material would be applied. The estimated cost for this alternative and assumptions used are presented in Table DF-2.3 in Appendix D. Capital costs are estimated to be $716,000. The present worth cost is the same as the capital cost assuming a four month project life.

Remediation of soils contaminated with TPH at the Revetment Area involves excavating and treating 23,500 cubic yards of soil. Approximately 77,260 cubic yards of cover yards of cover material would be applied. The estimated cost for this alternative and assumptions used are presented in Table DF-3.3 in Appendix D. Capital costs are estimated to be $5,324,000. The present worth cost is the same as the capital cost assuming a one year project life.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be somewhat difficult because of public perception regarding thermal treatment process.

6.3 SITE 4: PUMP STATION

The Pump Station and the sediments in the tidal wetland have been assigned to Operable Unit 2. Additional investigations will be conducted to further characterize the nature and extent of contamination. The alternative assessment in this report is based on the ecological-risk assessment in the EI (Engineering-Science 1993).

Both sediment and soil at the Pump Station contain analytes that exceed the sediment screening criteria and additional analytes identified by the ecological-risk assessment. Several metals, pesticides, and PAHs, exceeded the ecological risk criteria and are summarized in Table 2.6. All the soil and sediment samples throughout the site exceed 100 mg/kg TPH. As discussed in the ecological risk assessment, there are two sets of proposed sediment screening criteria; one which does not require a cover and the other with a cover. The cover would consist of 3 feet of soil or sediment that meets the no-cover criteria. Except for PS-SD-2 and PS-SD-3, every sediment sample analyzed at the pump station at least one metal (lead, manganese, nickel, silver, or zinc) or pesticide (DDT or DDD) that exceeds the no-cover cleanup criteria. Additional investigations by the Army Corps of Engineers however, detected metals that exceeded the with-cover criteria in the area near PS-SD-2 and PS-SD-3. All of the AST soil samples exceed the proposed sediment criteria for total PAHs (assuming no cover). PS-SD-3 and the soil stockpile (PS-SS-5, 6, and 8) only exceed the TPH remediation goal. Manganese was identified as a potential plant toxin based on concentrations detected at the site. However, since plants appear to thrive even in areas of high manganese concentrations, manganese is not considered in the alternative analysis.

The option of covering the site with 3 feet of clean backfill would require excavating soil throughout the site to comply with TPH cleanup goal (100 mg/kg). The drainage channel sediments east of the levee require treatment because all the soil samples exceed the 100 mg/kg TPH cleanup goal. The with-cover option requires that the top two feet of soil be excavated and treated provided 3 feet of clean or treated soil is used as a cover material. Selecting the with-cover option would reduce the total volume of soil treated, and reduce the volume of soil that requires treatment for metals, pesticides, and PAH contamination.

Sediment samples PS-SD-6 and 7 exceed the sediment criteria for lead, zinc, nickel, and also contains DDD. Samples PS-SD- 4 and 8 exceed the nickel sediment criteria. Sample TP-SD-3 was collected in the tidal wetlands near the FSTP and exceeds the nickel sediment criteria. The sediment in the tidal wetlands is part of Operable Unit 2. AST soil samples PS-SS-1, 2, and 3 exceed the total PAH sediment criteria.

Approximately 810 cubic yards of soil is contaminated with only TPH and, assuming the with-cover option, another 22,590 cubic yards of soil and sediment require remediation for TPH and other contaminants as well.

Remedial alternatives retained for this site include:

- S1: No Action
- S2/S6: Excavation, Capping and Biotreatment
- S2/S8: Excavation, Capping and Low Temperature Thermal Desorption
- S2/S6/S7: Excavation, Capping and Biotreatment followed by Solidification/Stabilization
- S2/S7/S8: Excavation, Capping and Low Temperature Thermal Desorption followed by Solidification/Stabilization
- S2/S7/S9: Excavation, Capping and Off-site Thermal Destruction followed by Solidification/Stabilization
- S2/S7/S11: Excavation, Capping and Chemical Oxidation followed by Solidification/Stabilization
- S2/S12: Excavation, Capping and Soil Washing.

The following eight sections present the evaluation for the eight alternatives retained. Additionally, Figure 6.3. is a summary of the detailed analysis relative to the evaluation criteria. This figure is subdivided by types of contaminants. Certain alternatives are more applicable to specific types of contaminants and costs have been estimated assuming a given chemistry and volume for similar contamination. At least one alternative from each category needs to be selected and combined with other selected alternatives for a final remedy.

6.3.1 S1: No Action (Pump Station).

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place.

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to the environment would not change. This alternative does not fulfill the intent of CERCLA/SARA by providing permanent protection of the environment.

Compliance with ARARs: The no action alternative would not be in compliance with remedial action objective for TPH, DDD, DDT, and metals in the sediment and PAH and TPH in the soil. There are no action-specific ARARs pertaining to a no action alternative. Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: The no action alternative would not be effective in reducing contamination. TPH and PAH contamination may naturally degrade over time, however this cannot be accurately predicted. Metals and pesticides would remain.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants.

FIGURE 6.3

Evaluation of Soil Remedial Alternatives Wetland Option

Site 4: Pump Station Area

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	◔	○	◔	○	◕	◕	○	○	1,000
TPH and PAH	S2/S6: Excavation, Capping & Biological Treatment (d)	◕	◕	◕	◕	◕	◕	●	●	129,000
	S2/S8: Excavation, Capping & Desorption (d)	◑	◑	◕	◕	◑	◑	◑	◑	281,000
TPH and Metals	S2/S6/S7: Excavation, Capping & Biological Treatment Solidification/ Stabilization (d, g)	◕	◕	◕	◕	◕	◕	●	●	111,000
	S2/S8/S7: Excavation, Capping Desorption Solidification/ Stabilization (d, g)	◕	◕	◕	◕	◑	◕	◕	◑	127,000
Pesticides, TPH, PAH, and Metals	S2/S9/S7: Off-site/ Thermal Destruction Solidification/ Stabilization (e)	●	●	●	●	◕	◕	◕	◕	54,502,000 (h)
	S2/S11/S7: Chemical Oxidation Solidification/ Stabilization (d, e)	◑	◑	◑	◑	◑	◑	◑	◑	6,260,000 (h)
	S2/S12: Soil Washing (d, e)	◑	◑	◑	◑	◑	◑	◕	◕	5,919,000 (h)

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars. No Action Assumes One Time Collection of Water and No Groundwater Monitoring. Monitoring Costs for Remedial Alternative are not Included.

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for Those Sediments Only Contaminated with TPH, Metals, PAHs, and Pesticides

(f) This Alternative is Considered for Those Soils Only Contaminated with TPH or TPH and PAH

(g) This Alternative is Considered for Those Soils Only Contaminated with TPH, PAH, and Metals

(h) Cost is for AST-6 Soils (160 c.y.) and Pump Station Sediments (22,220 c.y.).

Short-term effectiveness: There are no impacts to the community and site workers resulting from the implementation of this alternative. The contaminated soil would continue to pose a risk to the environment. Remedial objectives may never be achieved.

Implementability: This alternative is readily implemented technically, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: If there is no groundwater monitoring and no soils treatment, then there would be no costs associated with the no action alternative. A variation of the no action alternative is considered at the Pump Station site. This would involve a one-time collection of free water from any remedial excavation. The cost to collect and treat the groundwater is $1,000. The cost is kept separate in order to be easily combined with soil/sediment remedial alternatives in Section 7, Conclusions. This alternative assumes soil/sediment remediation will take place.

State acceptance: Regulatory acceptance would be difficult because this alternative would not achieve the TPH cleanup goal of 100 mg/kg through treatment, and other remediation objectives.

Community acceptance: Community acceptance would also be difficult because the environment risks are not addressed by this alternative.

6.3.2 S2/S6: Excavation, Capping and Biological Treatment (Pump Station).

Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit and either tilling soil or drawing air through soil piles to aerate. Nutrients or microorganisms could be added to enhance degradation. Typically degradation is assumed to take 6 to 18 months. A process flow diagram is shown in Appendix E.

Biological treatment has been proven effective for degrading TPH and may be applicable for PAH. The average removal PAH efficiency is around 87 percent based on bench scale and pilot scale tests. This is sufficient to achieve the with-cover sediment criteria. Much of the site does not require metals remediation. Biotreatment without metals treatment would be considered for those areas.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit possibly including vent pipe and blower
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Till soils or draw air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Analyze for TCLP RCRA metals

- Regrade site
- Apply additional cover material if needed to comply with SFRWQCB requirements and in areas exceeding 10 mg/kg TPH

Protection of human health and the environment: Bioremediation is effective for TPH and potentially effective for PAH. Biodegradation has not been proven to be successful on a commercial scale for degrading pesticide (DDT/DDD) contamination. This technology may not provide protection of the environment at sites contaminated with metals or pesticides.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil and under favorable conditions the TPH remedial action objective may be attained. Bioremediation could potentially reduce PAH concentration up to 87% (EPA 1990c). This is sufficient reduction to attain the with-cover sediment criteria. The soil near AST-6 which contains PAHs is also contaminated with beta benzene hexachloride (BHC) which is not readily degraded. BHC was not specifically identified as a contaminant of concern in the ecological risk assessment. An alternative treatment should be used to treat pesticides and metal contaminated soils and sediments.

All the action-specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action-specific ARARs include excavation, stockpiling, air emissions, land treatment, placement of treated soil and covering area according to SFRWQCB requirements. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto the land until the hazardous constituents are treated with a specific treatment technology or until constituent concentrations are reduced below specific levels.

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: Bioremediation would be protective in the long-term for TPH and PAH contaminated soil provided a cover material is applied in accordance with SFRWQCB requirements.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation would reduce the TPH and PAH contamination. An alternate technology could be used to treat the metal and pesticide contaminated soil.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. There is minimal risk to the public during remediation. Remediation would be complete in approximately 2 years.

Implementability: Bioremediation may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: Remediation of soils contaminated with TPH at the Pump Station involves excavating and treating 700 cubic yards of soil from the stockpile and 110 cubic yards of soil near AST-5 (810 cubic yards total). In addition, 270 cubic yards of material should be applied as cover to the area at AST-5 and 380 cubic yards at the stockpile. The estimated cost for this alternative and assumptions used are presented in Table DF-4.2 in Appendix D. Capital costs are estimated to be $37,000 and annual costs are estimated to be $53,000 per year. The present worth cost is estimated to be $129,000 assuming a two-year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable because this technology will likely degrade TPH contaminants.

Community acceptance: Community acceptance may be attainable because of public perceptions regarding active treatment of contaminants

6.3.3 S2/S8: Excavation, Capping and Low Temperature Thermal Desorption (Pump Station)

Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments or sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800° F) can be adjusted to remove the TPH contaminants.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment end products include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area if residual metals levels are sufficiently low. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal

- Regrade site
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon
- Apply additional cover material if needed to comply with SFRWQCB requirements and in areas exceeding 10 mg/kg TPH

Protection of human health and the environment: The risk to the environment, and the risk resulting from migration of TPH contaminants to groundwater would be reduced because most of the TPH contamination source would be removed.

Compliance with ARARs: A cleanup goal for TPH (10 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. However, if heavy hydrocarbons or oils are present, this desorption may not be able to remove all of the contamination. A treatability study is needed for confirmation.

With proper technology implementation, action-specific ARARs that apply to low temperature thermal desorption would be met. Action-specific ARARs include excavation, stockpiling, air emissions placement of treated soil and covering area according to SFRWQCB requirements. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

This alternative can be made consistent with location-specific ARARs with careful management of discharge and construction. Location-specific ARARs for wetlands, critical habitats and endangered species protection must be studied during the design phase of this alternative.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the TPH contamination would be removed in the soil, thus removing the potential groundwater contamination source.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption would reduce the TPH contaminants toxicity, mobility and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emission must be monitored and controlled. Remediation is expected to be complete in one year.

Implementability: Low temperature thermal desorption may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: Remediation of soils contaminated with TPH at the Pump Station involves excavating and treating 810 cubic yards of soil from the stockpile and near AST-5. In addition, 270 cubic yards of cover material should be applied to the area at AST-5 and 380 cubic yards at the stockpile. The estimated cost for this alternative and assumptions used are presented in Table DF-4.3 in Appendix D. Capital costs are estimated to be $281,000 and the project is estimated to take 6 months. The present worth cost is equal to the capital cost.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contaminated soil.

Community acceptance: Community acceptance may be difficult because of public perception regarding the thermal treatment process.

6.3.4 S2/S6/S7: Excavation, Capping and Biological Treatment followed by Solidification/Stabilization (Pump Station).

Biological treatment followed by solidification/stabilization is a treatment alternative effective in treating organic contaminants by biological treatment followed by residual metals management. The process begins with conventional biological treatment. Soils are excavated and placed in a controlled treatment unit. The soil is aerated either mechanically by tilling or passively by drawing air through vent pipes placed in soil piles. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade a wide range of organics including TPH. Nutrients or special microorganisms can also be added to enhance the remediation process.

Upon completion of the bioremediation, solidification additives are mixed with the metals contaminated soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, analytical and physical characterization must be performed to ensure compatibility and effectiveness. A process flow diagram is shown in Appendix E.

Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988). It is also effective in immobilizing PAH contamination based on bench scale tests (EPA 1990c).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the bioremediation treatment unit
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils and nutrients as needed
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress

- Application of solidification agents
- TCLP metals analysis
- Provide additional cover material if needed per SFRWQCB requirements and in across exceeding 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: Biodegradation followed by solidification/stabilization would be effective in protecting human health and the environment against TPH, PAH, and heavy metals. However, bioremediation has not demonstrated its effectiveness in degrading DDD or DDT on a commercial scale (EPA 1988). DDT and DDD may be treated by solidification/stabilization, but a treatability test would be needed to confirm.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the TPH and PAH remedial action objective may be attained. Solidification/stabilization may be effective in immobilizing residual PAH contaminants and metals based on bench and pilot scale tests (EPA 1990c). It may be possible to comply with the no-cover criteria by applying the combined bioremediation followed by solidification alternative. A treatability test would be needed to confirm treatment effectiveness. An alternative treatment might be used if necessary to treat DDD and DDT contaminated soil. Bioremediation/solidification could be used to treat soils that do not have DDD or DDT. Solidification/stabilization would fulfill metal requirements.

All action-specific ARARs that apply to excavation and biotreatment and solidification/ stabilization would be met with proper technology implementation. Action-specific ARARs include excavation, stockpiling, air emissions, land treatment, placement of treated soil and covering area according to SFRWQCB requirements. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location-specific ARARs do not apply for Wetland Option.

Long-term effectiveness and permanence: Bioremediation followed by solidification/stabilization would not be protective in the long-term because TPH and PAH would be removed in the soil and the heavy metals would be immobilized.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation followed by solidification/stabilization would reduce the toxicity, mobility, and volume of TPH, PAH, and metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, which could be

minimized with engineering controls and personal protection equipment. There is minimal risk to the public during remediation. Cleanup time is expected to be approximately two years.

Implementability: Bioremediation followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated.

Cost: Remediation of soils contaminated with TPH, and metals at the Pump Station involves excavating and treating 210 cubic yards of soil near AST-7. In addition, 440 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-4.4 in Appendix D. Capital costs are estimated to be $64,000 and annual costs are estimated to be $27,000 per year. The present worth cost is estimated to be $111,000 assuming a two-year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable due to this technology's likely effectiveness in remediating TPH, PAH, and metals. Another technology could be selected for treating soils contaminated with DDD or DDT.

Community acceptance: Community acceptance should be attainable because of the public perceptions regarding active treatment of contaminants.

6.3.5 S2/S8/S7: Excavation, Capping and Low Temperature Thermal Desorption Followed by Solidification/Stabilization (Pump Station).

Low temperature thermal desorption followed by solidification/stabilization is a combined treatment alternative to remediate organics and heavy metals. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Solidification additives are then mixed with the treated soils from the thermal desorption unit. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness.

Low temperature thermal desorption would be successful in removing the TPH and other contamination. The vapor pressure of the PAH contaminants is less than TPH and thermal desorption will not be as effective at the same operating conditions. However, no reference source was obtained stating that low temperature thermal desorption has been proven on a commercial scale for the removal of PAHs, DDD, or DDT. Both DDT and DDD have very low volatility and are not likely to be treated effectively by low temperature thermal desorption. It may be possible to treat DDD/DDT by

solidification/stabilization process. A treatability test is needed to confirm treatment effectiveness. Solidification/stabilization is a demonstrated effective technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pad
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal
- Application of solidification agents
- TCLP metals analysis
- Regrade site
- Apply additional cover material if needed per SFRWQCB requirements and in areas that exceeds 10 mg/kg TPH
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: Low temperature thermal desorption followed by solidification/stabilization would be effective in protecting the environment against TPH, and heavy metals. The technology's effectiveness in reducing the risk posed from the PAHs, DDD and DDT can not be explicitly evaluated because the technology's effectiveness has not been proven on a commercial scale at other CERCLA sites. A treatability study would need to be conducted if this alternative is selected. A treatability test is needed to confirm if solidification/stabilization is effective in treating PAHs, DDD and DDT.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil and will likely reduce PAH concentration 50 to 65 percent (EPA 1990c). Solidification/stabilization has demonstrated effectiveness in managing heavy metals. Solidification/stabilization may be effective in immobilizing PAHs, DDD and DDT, however, a treatability test is needed to confirm this.

With proper technology implementation, action-specific ARARs that apply to low temperature thermal desorption followed by solidification/stabilization would be met. Action-specific ARARs include excavation, stockpiling, air emissions, and applying additional cover material if needed. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be

classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste RCRA land disposal restrictions will apply.

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: Low temperature thermal desorption followed by solidification/stabilization would be protective in the long-term for soils contamination with TPH and metals because TPH would be removed and the heavy metals would be stabilized. Solidification/stabilization may be effective in treating low concentrations of PAH, DDT, or DDD, however, it has not been proven to be successful on a commercial scale. A treatability study would need to be conducted to determine the long-term effectiveness.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption followed by solidification/stabilization would reduce the toxicity, mobility, and volume of TPH, PAHs, DDT, DDD, and heavy metals.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, which may be minimized with engineering controls and personal protection equipment. Air emissions must be monitored and controlled. The remediation period is expected to be one year.

Implementability: Low temperature thermal desorption followed by solidification/stabilization may be readily implemented as they are proven technologies, components are commercially available, and it can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes. DDD and DDT are highly chlorinated aromatic compounds and the air board would likely be very reluctant to permit thermal desorption of soils contaminated with halogenated compounds. It may be possible to attain a permit to treat PAH by this alternative.

Cost: Remediation of soils contaminated with TPH, and metals at the Pump Station involves excavating and treating 210 cubic yards of soil near AST-7. In addition, 440 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-4.5 in Appendix D. Capital costs are estimated to be $127,000. The present worth cost is the same as the capital cost assuming a six-month project life.

State acceptance: Regulatory acceptance is not likely for soils contaminated with DDD or DDT. State agencies may accept thermal desorption for those soils that are not contaminated with chlorinated compounds provided an alternate treatment is selected for DDD and DDT contamination. The soils near AST-6, however, contain beta benzene hexachloride which is not readily treated by thermal desorption.

Community acceptance: Community acceptance may be difficult because of perception regarding thermal treatment processes in their communities.

6.3.6 S2/S9/S7: Excavation, Capping and Off-site Thermal Destruction Followed by Solidification/Stabilization (Pump Station).

This alternative is initiated with conventual excavation of the contaminated sediment followed by off-site transportation which may be completed by truck or rail. Treatment of contaminated soil involves incineration at high temperature (>2000° F) to destroy and remove contaminants. The treatment facility is responsible for and will certify the destruction of the waste, treatment of the off-gas, and final disposal of incinerator residuals (ash). A process flow diagram is shown in Appendix E.

Disposal of the incineration ash would require solidification if heavy metal concentrations exceed action-specific ARARs requiring treatment of the residual ash prior to land disposal with solidification/stabilization. The process involves the addition of solidification additives mixed with the residual ash. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

A significant portion of the cost for off-site incineration is transportation, because California does not have a commercial incineration facility. For costing purposes, the Rollins Facility in Deer Park, Texas was selected as the designated incineration facility.

The sequence of activities that would be performed in this alternative consist of the following:

- Excavation of contaminated soils
- Transportation of contaminated soils to off-site incineration facility
- Incineration
- Application of solidification agents to residual ash
- TCLP metals analysis
- Disposal of solidified ash
- Apply cover material per SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: This alternative provides protection for the environment by providing a proven remedy that destroys the organic contaminants present and successfully manages the remaining inorganics, providing a long-term permanent solution.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Off-site incineration is proven to be an effective treatment for the remediation of PAH, TPH, DDT, and DDD contamination in soil. Solidification/stabilization has demonstrated effectiveness in managing heavy metals.

Action-specific ARARs that apply to off-site incineration followed by solidification/stabilization include excavation, providing a cover if needed per SFRWQCB requirements, air emissions, and Department of Transportation requirements. Additionally, the designated incineration facility will be responsible for fulfilling action-specific ARARs that apply to their process. These ARARs include incineration ARARs as presented in Appendix F, Table F-2, which would be applicable if the waste is determined to be a RCRA hazardous waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste). All action-specific ARARs may be met with proper technology implementation.

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: This alternative would result in complete destruction of TPH, PAH, DDD, and DDT contamination. The heavy metals contamination would be effectively managed by solidification/stabilization.

Reduction of toxicity, mobility, or volume through treatment: Off-site incineration would be effective in reducing the toxicity, mobility, or volume of the organic contaminants. The mobility of the heavy metal contamination would be reduced by solidification/stabilization.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation and material handling. However, with engineering controls and personal protection equipment the technology can be implemented effectively. The off-site facility should meet RCRA requirement and be protective of the community.

Implementability: Off-site incineration followed by solidification/stabilization may be readily implemented as it is a proven technology, and it can be reliably operated. However, RCRA facility capacity may be limiting.

Cost: Remediation of sediments contaminated with TPH, PAHs, pesticides and metals involves excavating and treating 22,220 cubic yards of sediment. In addition, 33,300 cubic yards of cover material will be applied to the area of contamination in the tidal wetlands. The estimated costs for this alternative and assumptions used are presented in Table DF-4.9 in Appendix D. Capital costs are estimated to be $54,105,000. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable because this alternative would result in complete destruction of organic contaminants and management of the inorganics by controlling their mobility. The state would prefer that soil treatment and disposal be done on site if possible.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk. The public would prefer not to transport hazardous materials for treatment if possible.

6.3.7 S2/S7/S11: Excavation, Capping and Chemical Oxidation followed by Solidification/Stabilization (Pump Station).

Chemical oxidation processes are an effective remedial alternative for the treatment of organic contaminants by transforming contaminants into less toxic substances. Oxidizing agents such as ozone and hydrogen peroxide are added to the sediment facilitate organic contaminant degradation. The oxidizing agents attack carbon-carbon bonds oxidizing the organic species to carbon dioxide and water. In the process, the sediments would be mixed with the oxidizing agent and placed into a controlled treatment unit for continued contaminant degradation. A process flow diagram is shown in Appendix E. Solidification/stabilization is a demonstrated technology for the treatment of heavy metals and it has been employed at several CERCLA sites in repeated applications (EPA 1988).

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of sediment storage pads and processing system
- Convey soils to processing system for application of oxidizing agents
- Placement of sediments into treatment unit
- Sample treated sediments to monitor contaminant removal
- Application of solidification agents
- TCLP metal analysis
- Provide additional cover material if needed per SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: The risk to the environment would be reduced. However, DDT and DDD would degrade to DDE as an intermediate reaction product which is also toxic. Continued treatment by chemical oxidation could ultimately produce nontoxic end products and acid. The acid can be neutralized by conventional techniques. A treatability test is needed to confirm whether chemical oxidation is effective for PAHs, DDD, and DDT.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Chemical oxidation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. The efficiency of chemical oxidation in treating PAH, DDD, and DDT is not known and a treatability study is needed. Solidification/stabilization would reduce the mobility of PAH, pesticides and metals.

With proper technology implementation, action specific ARARs that apply to excavation and chemical oxidation would be met. Action specific ARARs include excavation, stockpiling, air emissions, on-site replacement of treated sediment, providing additional cover material if required, and possible treatment of spent oxidizing solution. These requirements may require compliance to RCRA waste levels if the sediment is

determined to be a RCRA waste. For the sediment to be classified as a RCRA waste, the sediment contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the sediment is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: Chemical oxidation would be protective in the long-term because most of the TPH contamination would be transformed into less toxic substances in the sediment. Chemical oxidation is typically not used to treat PAH or pesticides. The efficiency of chemical oxidation in treating PAH and DDD/DDT is not known and a treatability study is needed. Solidification/stabilization would reduce the mobility and impact of nickel and other contaminants.

Reduction of toxicity, mobility, or volume through treatment: Chemical oxidation would reduce the toxicity, mobility, and volume of the TPH and metal contamination. Chemical oxidation could create toxic intermediate products. Additional tests to confirm complete destruction of DDT, DDD and intermediate products would be needed. The effect of chemical oxidation on PAH is not known.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. The risk to the community is minimal during remediation since contaminants will be destroyed. The remediation period is approximately one year.

Implementability: Chemical oxidation and solidification/stabilization technologies may be readily implemented since, components are commercially available.

Cost: Remediation of sediments contaminated with TPH, PAHs, pesticides and metals at the Pump Station involves excavating and treating 22,200 cubic yards of soil. In addition, 33,300 cubic yards of cover material will be applied to the area of contamination in the tidal wetlands. The estimated cost for this alternative and assumptions used are presented in Table DF-4.10 in Appendix D. Capital costs are estimated to be $6,102,000. There are no groundwater monitoring costs associated with the Wetland Option. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable provided additional sampling is included to insure that intermediate products are also remediated during treatment.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

6.3.8 S2/S12: Excavation, Capping and Soil Washing (Pump Station)

Direct soil washing is a chemical/physical treatment method for organic and heavy metal contaminated soils. It extracts contaminants from soil and sediment with washing solution such as water, organic solvents, surfactants, acids, or bases. Prior to selecting the

washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After treatment, the detoxified soil can be returned to the excavation as fill material. A process flow diagram is shown in Appendix E.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger the .25 inches from soil
- Shred material larger than .25 inches
- Convey soils to processing system
- Treat soils with washing solution
- Dewater treated soils
- Sample treated soil to monitor contaminant removal
- Treatment of waste water (washing solution)
- Provide additional cover material if needed per SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrade site

Protection of human health and the environment; Soil washing is an effective technology for the treatment of DDT, DDD, DDE, and some heavy metals in soils. Soil washing is only marginally effective in treating PAH concentration (80 percent average removal effective) (EPA 1990c).

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Other chemicals of concern include PAHs, pesticides and heavy metals. Washing additives would be selected that would remediate chemicals of concern. Sequential washing steps may be needed in order to comply with chemical specific ARARs.

All the action specific ARARs that apply to excavation and soil washing would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, providing additional cover material if required by SFRWQCB, and possibly treatment of washwater prior to discharge. These ARARs may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the sediment is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: Soil washing may be protective in the long-term because the heavy metals and organics would be removed from the soil and

sediment, thus preventing direct contact with the contaminated sediment, and minimizing potential leaching of the residual contaminants. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern.

Reduction of toxicity, mobility, or volume through treatment: Soil washing may reduce the toxicity, mobility, and volume of the heavy metals and small amounts of organics at the site. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however, engineering controls and personal protection equipment can minimize exposure. The process would remove contaminants from the soil.

Implementability: Soil washing may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: Remediation of sediments contaminated with TPH, PAHs, pesticides and metals involves excavating and treating 22,220 cubic yards of sediment. In addition, 33,300 cubic yards of cover material will be applied to the area of contamination in the tidal wetlands. The estimated cost for this alternative and assumptions used are presented in Table DF-4.11 in Appendix D. Capital costs are estimated to be $5,675,000. There are no groundwater monitoring costs associated with the Wetland Option. The present worth cost is the same as the capital cost assuming a twelve month project life.

State acceptance: Regulatory acceptance should be attainable if a treatability study demonstrates that the technology is effective in removing the chemical of concern from the soil and sediment.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the environment should be favorable if the technology is proven effective.

6.4 SITE 5: FORMER SEWAGE TREATMENT PLANT

Soils in the former sludge drying beds require remediation due to the presence of pesticides identified in the EI ecological risk assessment (DDT, DDD, DDE, dieldrin, and endrin) and metals (mercury and silver) which exceed the no-cover sediment screening criteria (Engineering-Science 1993). Two of the analytes, mercury and dieldrin pass the with-cover sediment criteria. Sample TP-MW-101 exceeds the SFRWQCB nickel criteria and requires the area be covered. Soils in the sludge drying beds also exceed the TPH cleanup goal (100 mg/kg). The sediments do not require remediation based on samples taken for the Environmental Investigation and the ecological risk assessment. Sample TP-SD-3 exceeds the SFRWQCB nickel criteria. However, since this sample is in the tidal wetland, it has been assigned to Operable Unit 2 and is discussed as part of the Pump Station. TPH concentrations were not measured in the sediment samples. Table 2.6 summarizes the analytes that require remediation at the former sewage treatment plant. The with-cover option requires that the top two feet of soil be excavated and treated provided 3 feet of clean or treated soil is used as a cover material. Selecting the with-

cover option would reduces the total volume of soil treated, and reduce the volume of soil that requires treatment for metals, pesticides, and PAH contamination.

Remedial alternatives retained for this site include:

- S1: No Action;
- S2/S9/S7: Excavation, Capping and Thermal Destruction followed by Solidification/Stabilization;
- S2/S11/S7: Excavation, Capping and Chemical Oxidation followed by Solidification/Stabilization; and
- S2/S12: Excavation, Capping and Soil Washing.

The following four sections present the evaluation for these alternatives relative to the evaluation criteria. Additionally, Figure 6.4 presents the summary of the retained remedial alternatives relative to the evaluation criteria.

6.4.1 S1: No Action (FSTP)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil and sediment at this site would consist of no remedial activities. The soil would remain in place.

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to the environment would not change. This alternative does not fulfill the intent of the CERCLA/SARA by providing permanent protection of the environment.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established and is exceeded under this alternative. Other chemicals of concern that exceed ecological risk goals or the sediment screening criteria include pesticides and heavy metals. There are no action specific ARARs pertaining to a no action alternative. Location specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: The no action alternative would not be directly effective in reducing residual contamination. TPH would naturally degrade over time, but pesticides and metals will likely persist.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-term effectiveness: With the no action alternative, there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative.

Implementability: This alternative is readily implemented, because no remedial actions are required. However, administrative implementation may be difficult due to state and community acceptance.

FIGURE 6.4

Evaluation of Soil Remedial Alternatives Wetland Option

Site 5: Former Sewage Treatment Plant Area

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Permanence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implementability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
	S1: No Action	No	No	No	No	Moderate	Moderate	No	No	31,000
PCB, Pesticides, TPH, and Metals	S2/S8/S7: Excavation, Capping & Thermal Destruction Solidification/ Stabilization (e)	High	High	High	High	Moderate	Moderate	Moderate	Moderate	2,697,000
	S2/S11/S7: Excavation, Capping & Oxidation Solidification/ Stabilization (d)	Partial	Partial	Partial	Partial	Partial	Partial	Moderate	Partial	367,000
	S2/S12: Excavation, Capping & Washing (d)	Partial	Partial	Partial	Partial	Partial	Partial	Moderate	Moderate	408,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars
No Action Assumes One Year of Groundwater Monitoring.

(d) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(e) This Alternative is Considered for the Area near TP-SD-1 which is only Contaminated with Metals. The Remaining Alternatives Address the PCB, DDT, DDD, DDE, Aldrin and Metals Contamination

Cost: There are no costs associated with the no-action alternative if the Wetland Option is pursued. If there is no groundwater monitoring and no soils treatment, then there would be no costs associated with the no action alternative. A variation of the no action alternative is considered at the FSTP site. This would involve installing monitoring wells downgradient of the drying beds and quarterly monitoring for one year. The cost for this variation is $30,600 and the assumptions used are presented in Table DWM-5C in Appendix D. The cost for monitoring is kept separate in order to be easily combined with soil remedial alternatives in Section 7, Conclusions. This alternative assumes soil remediation will take place.

State acceptance: Regulatory acceptance may be difficult to attain because this alternative will not provide complete protection of human health and the environment.

Community acceptance: Community acceptance may also be difficult to attain due to public perceptions regarding land use and lack of active treatment of contaminants.

6.4.2 S2/S9/S7: Excavation, Capping and Off-site Thermal Destruction followed by Solidification/Stabilization (FSTP).

This alternative is initiated with conventual excavation of the contaminated soil followed by off-site transportation which may be completed by truck or rail. Treatment of contaminated soil involves incineration at high temperature (>2000° F) to destroy the contaminants. The treatment facility is responsible for and will certify the destruction of the waste, treatment of the off-gas, and final disposal of incinerator residuals (ash). A process flow diagram is shown in Appendix E.

Disposal of the incineration ash would require solidification if heavy metal concentrations exceed action specific ARARs requiring treatment of the residual ash prior to land disposal with solidification/stabilization. The process involves the addition of solidification additives mixed with the residual ash. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site.

This alternative is being considered for treating the soils in the former sludge drying beds. The area near TP-MW-101 will be covered with 3 feet of non-engineered fill. If TPH greater than 10 mg/kg remain then the area would also be covered with clean fill. The sequence of activities that would be performed in this alternative consist of the following:

- Excavation of contaminated soils
- Transportation of contaminated soils to off-site incineration facility
- Incineration
- Application of solidification agents to residual ash
- TCLP metals analysis

- Disposal of solidified ash
- Provide cover material if needed per SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: This alternative provides protection for the environment by providing a proven remedy that destroys the organic contaminants present and successfully manages the remaining inorganics, providing a long-term permanent solution.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Pesticides and metals detected throughout the former sludge treatment beds require treatment based on the ecological risk assessment. Off-site incineration is proven to be an effective treatment for the remediation of organic contamination in soil. Solidification/stabilization has demonstrated effectiveness in managing heavy metals.

Action specific ARARs that apply to off-site incineration followed by solidification/ stabilization include excavation, air emissions, and Department of Transportation requirements. Additionally, the designated incineration facility will be responsible for fulfilling action specific ARARs that apply to their process. These ARARs include incineration ARARs as presented in Appendix F, Table F-2, which would be applicable if the waste is determined to be a RCRA hazardous waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of hazardous waste).

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: This alternative would result in complete destruction of pesticides, and TPH contamination. The heavy metals contamination would be effectively managed by solidification/stabilization.

Reduction of toxicity, mobility, or volume through treatment: Off-site incineration would be effective in reducing the toxicity, mobility, or volume of the organic contaminants. The mobility of the heavy metal contamination would be reduced by solidification/stabilization.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation and material handling. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Incineration would destroy organic contaminants and metal would be immobilized by solidification.

Implementability: Off-site incineration may be readily implemented as it is a proven technology, and it can be reliably operated. However, RCRA facility capacity may be limiting.

Cost: Remediation of soils and sediments contaminated with TPH, PCB, pesticides and metals involves excavating and treating 1,200 cubic yards of soil and sediment. In addition 1,940 cubic yards of cover material will be applied to the area of contamination.

The estimated cost for this alternative and assumptions used are presented in Table DF-5.2 in Appendix D. Capital costs are estimated to be $2,697,000. The present worth cost is the same as the capital cost.

State acceptance: Regulatory acceptance should be attainable because this alternative would result in complete destruction of organic contaminants and management of the inorganics by controlling their mobility. The state would prefer that the soil be treated and disposed of on site if possible.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk. The public would prefer not to transport hazardous materials but instead treat the soil/sediment on site.

6.4.3 S2/S11/S7: Excavation, Capping and Chemical Oxidation Followed by Solidification/Stabilization (FSTP)

Chemical oxidation processes are an effective remedial alternative for the treatment of organic contaminants by transforming contaminants into less toxic substances. Oxidizing agents such as ozone and hydrogen peroxide are added to soil facilitate organic contaminant degradation. The oxidizing agents attack carbon-carbon bonds oxidizing the organic species to carbon dioxide and water. In the process, soils would be mixed with the oxidizing agent and placed into a controlled treatment unit for continued contaminant degradation. A process flow diagram is shown in Appendix E.

The solidification/stabilization treatment technology is typically used to immobilize heavy metal contamination. The technology uses solidification additives to immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. The process begins by conventionally excavating the contaminated soil and mixing the soil with the selected solidifying agent. Prior to selecting the solidification additives, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After the solidified mixture has passed the TCLP test, it can be returned to the excavation as fill material.

This alternative is being considered for treating the soils in the former sludge drying beds. The area near TP-MW-101 will be covered with 3 feet of non-engineered fill. If TPH greater than 10 mg/kg remain then the area would also be covered with clean fill. The sequence of activities that would be performed in this alternative consist of the following:

- Construction of soil storage pads and processing system
- Convey soils to processing system for application of oxidizing agents
- Placement of soils into treatment unit
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Sample treated (oxidized) soil to monitor contaminant removal

- Addition of solidification agents
- TCLP metal analysis
- Provide additional cover material if needed per SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: The risk to the environment from pesticides, and TPHs would be reduced because most of the contamination source would be transformed into less toxic substances or immobilized by solidification/stabilization additives. A treatability study is needed to confirm if chemical oxidation is effective for DDT and DDD.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Chemical oxidation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Pesticides detected throughout the former sludge treatment beds require treatment based on the ecological risk assessment. Chemical oxidation has not been proven in treating pesticides. A treatability study would be needed to determine effectiveness in attaining ARARs. Solidification/stabilization could immobilize the metals.

With proper technology implementation, action specific ARARs that apply to excavation and chemical oxidation would be met. Action specific ARARs include excavation, stockpiling, air emissions, placement of treated soil and covering area according to SFRWQCB requirements. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Location-specific ARARs do not apply for the wetland scenario.

Long-term effectiveness and permanence: TPH contamination would be transformed into less toxic substances in the soil. However, the effectiveness of treatment on pesticides needs to be evaluated. Solidification/stabilization would immobilize the metals.

Reduction of toxicity, mobility, or volume through treatment: Chemical oxidation followed by solidification/stabilization would reduce the toxicity, mobility, and volume of the contaminants. The significance of the reduction of contamination should be measured by a treatability study.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. A treatability study is needed to demonstrate chemical oxidation effectiveness in treating soils contaminated with pesticides.

Implementability: Chemical oxidation requires a treatability study prior to implementation to determine process conditions that could effectively treat pesticides, if

possible. The technology may be readily implemented and components are commercially available. Reliability during operations requires evaluation as part of the treatability study.

Cost: Remediation of soils and sediments contaminated with TPH, PCB, pesticides and metals involves excavating and treating 1,200 cubic yards of soil and sediment. In addition 1,940 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-5.3 in Appendix D. Capital costs are estimated to be $367,000. The present worth cost is the same as the capital cost.

State acceptance: A treatability study that demonstrates successful treatment of pesticide is needed in order to obtain regulatory acceptance.

Community acceptance: A treatability study that demonstrates successful treatment of pesticides is needed in order to obtain regulatory acceptance.

6.4.4 S2/S12: Excavation, Capping and Soil Washing (FSTP)

Soil washing is a chemical/physical treatment method for organic and heavy metal contaminated soils. It extracts contaminants from soil and sediment with washing solution such as water, organic solvents, surfactants, acids, or bases. Prior to selecting the washing solution, extensive analytical and physical characterization must be performed to ensure compatibility and effectiveness. After treatment, the detoxified soil can be returned to the excavation as fill material. A process flow diagram is shown in Appendix E.

This alternative is being considered for treating the soils in the former sludge drying beds. The area near TP-MW-101 will be covered with 3 feet of non-engineered fill. If TPH greater than 10 mg/kg remain then the area would also be covered with clean fill. The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger the 0.25 inches from soil
- Shred material larger than 0.25 inches
- Convey soils to processing system
- Treat soils with washing solution
- Dewater treated soils
- Sample treated soil to monitor contaminant removal
- Treatment of waste water (washing solution)
- Provide additional cover material if needed per SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrade site

Protection of human health and the environment; Soil washing is an effective technology for the treatment of DDT, DDD, DDE, and some heavy metals in soils. The effectiveness of soil washing on the remaining pesticides is not known and a treatability study would need to be completed to determine the technology's effectiveness for the chemicals of concern.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Other chemicals of concern include pesticides and heavy metals. Washing additives would be selected that would remediate chemicals of concern. Sequential washing steps may be needed in order to comply with chemical specific ARARs. A treatability study is recommended if soil washing is the selected remediation alternative.

All the action specific ARARs that apply to excavation and soil washing would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, placement of treated soil, and covering area according to SFRWQCB requirements and possibly treatment of washwater prior to discharge. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location-specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: Soil washing may be protective in the long-term because the heavy metals and organics would be removed from the soil. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern.

Reduction of toxicity, mobility, or volume through treatment: Soil washing may reduce the toxicity, mobility, and volume of the heavy metals and small amounts of organics at the site. However, a treatability study would be needed to determine the technology's effectiveness for the chemicals of concern.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment, however, engineering controls and personal protection equipment can minimize exposure. The process would remove contaminants from the soil.

Implementability: Soil washing may be readily implemented as it is a proven technology, components are commercially available, and it can be reliably operated.

Cost: Remediation of soils and sediments contaminated with TPH, PCB, pesticides and metals involves excavating and treating 1,200 cubic yards of soil and sediment. In addition 1,940 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-5.4 in Appendix D. Capital costs are estimated to be $408,000 and are the same as the present worth cost. The project life is estimated to be six months.

State acceptance: Regulatory acceptance should be attainable if a treatability study demonstrates that the technology is effective in removing the chemicals of concern from the soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the environment should be favorable if the technology is proven effective.

6.5 SITE 6: EAST LEVEE LANDFILL; SITE 8: FUEL LINES

Soil samples from the East Levee Landfill at EL-MW-101 and EL-MW-104 exceed the sediment screening criteria for lead assuming the no-cover option. Lead concentrations near EL-MW-101 (52 mg/kg) just barely exceeds the no-cover criteria (50 mg/kg). The lead concentrations at EL-MW-104 is 96 mg/kg. TPH was detected in the 1987 remedial investigation at levels that exceed the TPH criteria in two of five sample locations at 110 mg/kg each (Woodward-Clyde 1987). The with-cover option requires that the top two feet of contaminated soil be excavated and treated provided 3 feet of clean or treated soil is used as a cover material.

Similarly, average lead concentrations at the fuel lines exceeded the no-cover criteria but do not require remediation if 3 feet of capping material is applied. Samples were collected in the aircraft fueling turnouts and along the fuel lines. Lead concentrations in the fuel line area exceed the no-cover sediment screening criteria (50 mg/kg) in three samples, JP-SS-1, JP-SS-6 and JP-SS-10. The remainder of the site does not require cover material to be applied to comply with the SFRWQCB criteria. Concentrations ranged from non-detect to 264 mg/kg TPH throughout the area sampled. Five sample locations exceed 100 mg/kg TPH. Sites that require excavation and treatment to address the TPH concentrations include JP-SS-3, 6, 7, 8 and 9. This corresponds to the entire 6-inch fuel line. The entire 6-inch fuel line would be covered with 3 feet of material to cover areas contaminated with TPH greater than 10 mg/kg.

The Fuel Lines (Site 8) have been combined with the UST removal project and has been designated to Operable Unit 2. The East Levee Landfill remains in Operable Unit 1.

Remedial alternatives retained for detailed evaluation include:

- S1: No Action;
- S2/S6/S7: Excavation, Biological Treatment Followed by Solidification/Stabilization, and Capping; and
- S2/S8/S7: Excavation, Low Temperature Thermal Desorption Followed by Solidification/Stabilization, and Capping.

The following sections present the evaluation for the three alternatives. Additionally, Figure 6.5 is a summary of the analysis relative to the evaluation criteria.

FIGURE 6.5

Evaluation of Soil Remedial Alternatives Wetland Option

Site 6: East Levee Landfill and Site 8: Fuel Lines

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Perman-ence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implement-ability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c, g) $
TPH	S1: No Action	Low	Partial	Low	No	Moderate	Moderate	Partial	No	ELL: 7,500 (d) FL: 0 (e)
	S2/S6/S7: Excav., Biological Treatment, Solidification/ Stabilization, & Capping (f)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	ELL: 165,000 FL: 251,000
	S2/S8/S7: Excav., Thermal Desorption, Solidification/ Stabilization, & Capping (f)	Moderate	Moderate	Moderate	Moderate	Partial	Moderate	Moderate	Partial	ELL: 183,000 FL: 285,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- High level of compliance
- Moderate level of compliance
- Partial level of compliance
- Low level of compliance
- No level of compliance

(b) Level of Acceptance

- High level of acceptance
- Moderate level of acceptance
- Partial level of acceptance
- Low level of acceptance
- No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars

(d) No Action Assumes No Groundwater Monitoring. Decommission Wells

(e) No Action Assumes No Groundwater Monitoring.

(f) A Treatability Study is Recommended to Determine the Effectiveness of Alternative

(g) ELL: East Levee Landfill
FL: Fuel Lines

REV. 8 C336-18.DWG 05/06/94

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6.5.1 S1: No Action (East Levee Landfill and Fuel Lines)

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place.

Protection of human health and the environment: Under the no action alternative, no remediation would take place, and the risks to human health and the environment would not change. This alternative does not fulfill the intent of the CERCLA/SARA by providing permanent protection of human health and the environment.

Compliance with ARARs: Lead is the only analyte that needs to be addressed for the protection of the environment. Lead concentrations exceed the no-cover criteria of 50 mg/kg. The no action alternative would not be in compliance. There are no action specific ARARs pertaining to the no action alternative. Location specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: The no action alternative is not directly effective in reducing lead contamination.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative would not directly reduce the toxicity, mobility, or volume of contaminants.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative.

Implementability: This alternative is readily implemented technically, because no remedial actions are required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The no action alternative at East Levee Landfill involves decommissioning the five wells already in place. This is identical to the no action Development Option. At the Fuel Lines, there are no costs associated with the no-action alternative if the Wetland Option is pursued. There is no groundwater monitoring and no soils treatment.

State acceptance: Regulatory acceptance may be difficult because this alternative would continue to exceed the sediment screening criteria.

Community acceptance: Community acceptance may also be difficult due to public perceptions regarding land use and lack of active treatment of contaminants.

6.5.2 S2/S6/S7: Excavation, Capping and Biological Treatment Followed by Solidification/Stabilization (East Levee Landfill and Fuel Lines)

Biological treatment of contaminated soil has been proven effective for degrading TPHs. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit and either tilling the soil or drawing air through to aerate. Nutrients or microorganisms could be added to enhance degradation. Typically degradation is assumed to take 6 to 18 months. In addition 3 feet of capping material would be applied with the area at EL-MW-101 and EL-MW-104 in the East Levee

Landfill and along the 6 inch jet fuel line. A process flow diagram is shown in Appendix E.

Upon completion of the bioremediation, solidification additives are mixed with the soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization would be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposed of in a landfill.

The sequence of activities that would be performed in this alternative consist of the following:

- Soil sampling and analysis for TCLP metals
- Construction of the treatment unit (possibly including vent pipe and blower)
- Excavation of contaminated soils and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or draw air through the pipe
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Apply cover material as needed to comply with SFRWQCB requirements and in areas that exceed 10 mg/kg TPH
- Regrading the site

Protection of human health and the environment: The potential risk to the environment resulting from the TPH contamination would be reduced because the TPH contamination source would be degraded. The lead would be immobilized. The expected risk to the environment resulting from the lead and residual TPH at the site would be addressed by applying 3 feet of cover material in the areas where lead exceeds 50 mg/kg or where TPH exceeds 10 mg/kg.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. Lead in soil excavated due to TPH contamination would be solidified.

All the action specific ARARs that apply to excavation and biotreatment would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, and applying cover fill on-site. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location specific ARARs do not apply to the Wetland Option.

Long-term effectiveness and permanence: Bioremediation followed by solidification/stabilization would be protective in the long-term because most of the TPHs would be degraded in the soil and the lead immobilized.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation followed by solidification/stabilization would reduce the contaminants toxicity, mobility, and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Exposure to community during remediation is minimal. Treatment would remove source of contamination. Estimated remediation period is 2 years.

Implementability: Bioremediation followed by solidification/stabilization and capping may be readily implemented as they are proven technologies, components are commercially available, and they can be reliably operated.

Cost: Remediation of soils and sediments contaminated with TPH and lead at East Levee Landfill involves excavating and treating 280 cubic yards of soil. In addition 7,500 cubic yards of cover material will be applied to the area of lead contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-6.2 in Appendix D. Capital costs are estimated to be $109,000 and annual costs are estimated to be $32,000 per year. There are no groundwater monitoring costs associated with the Wetland Option. The present worth cost is estimated to be $165,000 assuming a two years project life and ten percent annual interest rate.

Remediation of soils and sediments contaminated with TPH and lead at the fuel lines involves excavating and treating 670 cubic yards of soil. In addition, 1,830 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-8.2 in Appendix D. Capital costs are estimated to be $133,000 and annual costs are estimated to be $68,000 per year. There are no groundwater monitoring costs associated with the Wetland Option. The present worth cost is estimated to be $251,000 assuming a two year project life and ten percent annual interest rate.

State acceptance: Regulatory acceptance should be attainable.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

6.5.3 S2/S8: Excavation, Capping and Low Temperature Thermal Desorption Followed by Solidification/Stabilization (East Levee Landfill and Fuel Lines)

Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments or sludges. The process begins by excavating

the contaminated soil and processing it through a rotary dryer used to heat the contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800°F) can be adjusted to remove the TPH contaminants.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense out as liquids the organic contaminant and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area if residual lead levels are sufficiently low. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal.

Upon completion of the thermal desorption, solidification additives are mixed with the soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization would be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposed of in a landfill.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils and transport to storage pad
- Screen all material larger than 2 inches from soil
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Sample treated soil to monitor contaminant removal;
- Regrade site
- Off-site recycle/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: The potential risk to the environment resulting from the TPH contamination would be reduced because the TPH contamination source would be removed. Lead in the areas of TPH contamination would be solidified. Soils also contaminated by lead throughout the remainder of the site would be covered with 3 feet of capping material.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Low temperature thermal desorption has been proven to be an effective treatment for the

remediation of TPH contamination in soil. Under favorable conditions the remedial action objective may be attained. Lead in the areas of TPH contamination would be solidified. The lead contamination throughout the remainder of the site would remain unchanged.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, placement of treated soil, and covering area according to SFRWQCB requirements. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply.

Location specific ARARs do not apply to the Wetland Option.

Long-term effectiveness and permanence: Low temperature thermal desorption followed by solidification/stabilization would be protective in the long-term because most of the TPHs would be removed from the soil and the lead immobilized. Areas where lead concentrations exceed 50 mg/kg throughout the remainder of the site would be covered with 3 feet of material.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption followed by solidification/stabilization would reduce the contaminants' toxicity, mobility, and volume.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emission must be monitored and controlled. Remediation period would be less than one year.

Implementability: Low temperature thermal desorption followed by solidification/stabilization and capping may be readily implemented as they are proven technologies, components are commercially available, and they can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: Remediation of soils and sediments contaminated with TPH and lead at the East Levee landfill involves excavating and treating 280 cubic yards of soil. In addition 7,500 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-6.3 in Appendix D. Capital costs are estimated to be $183,000 which is the same as the present worth cost. There are no groundwater monitoring costs associated with the Wetland Option.

Remediation of soils and sediments contaminated with TPH and lead at the Fuel Lines involves excavating and treating 670 cubic yards of soil. In addition 1,830 cubic yards of cover material will be applied to the area of contamination. The estimated cost for this alternative and assumptions used are presented in Table DF-8.3 in Appendix D. Capital

costs are estimated to be $285,000 which is the same as the present worth cost. There are no groundwater monitoring costs associated with the Wetland Option.

State acceptance: Regulatory acceptance should be attainable. Since thermal desorption followed by solidification/stabilization has been shown to be effective in remediating TPH and lead contaminated soil.

Community acceptance: Community acceptance may be difficult because public perception regarding thermal treatment process.

6.6 SITE 7: AIRCRAFT MAINTENANCE

The Aircraft Maintenance Area is divided into two subsections: Soil and sediments. The soil and the sediments in the storm drain vaults are part of Operable Unit 1. The sediments in the drainage channel are in Operable Unit 2.

6.6.1 Soil Contamination

Soils at the Aircraft Maintenance Area exceed the TPH criteria (100 mg/kg) at three sample areas, two by Building 86: AM-TP-1 (4650 mg/kg), AM-SB-2 (143 mg/kg), and AM-SB-10 by Building 87 (1060 mg/kg). Three samples at Aircraft Maintenance (AM-SB-5, AM-SB10, and AM-MW-104) exceed the SFRWQCB nickel sediment screening criteria of 90 mg/kg, but and less than 140 mg/kg and therefore do not require excavation and treatment. Contamination appears to be contained in the backfill material and does not migrate readily into the Bay Mud subsurface soils. The backfill material is approximately 2 to 4 feet deep and the areas of TPH contamination can be readily excavated for treatment. Beryllium is present in the fill material throughout the Aircraft Maintenance site. The SFRWQCB has agreed to applying cover material rather than excavating the fill material at the site. A significant portion of the Aircraft Maintenance Site will be covered with 3 feet of non-engineered fill over areas new Storage Areas 2 and 4 that are not already paved with concrete. This area include areas containing 10 mg/kg TPH and the three areas containing nickel above SFRWQCB screening level.

In situ alternatives cannot be considered for the wetland scenario since the actual time to clean up the site cannot be accurately predicted and the remediation process could exceed one year. Remedial alternatives retained for the soils include:

S1: No Action;

S2/S6/S7: Excavation, Biological Treatment, followed by Solidification/ Stabilization and Capping; and

S2/S8/S7: Excavation, Low Temperature Thermal Desorption, followed by Solidification/Stabilization .

The following three sections present the evaluation for these alternatives to the nine evaluation criteria. Additionally, Figure 6.6 presents a summary of the detailed analysis of the remedial alternatives retained relative to the evaluation criteria.

6.6.1.1 S1: No Action (Aircraft Maintenance-Soils).

The no action alternative was retained after evaluation in the screening stage to provide a basis of comparison to the other alternatives. The no action alternative for soil at this site would consist of no remedial activities. The soil would remain in place. The wells would be decommissioned.

Protection of human health and the environment: No risk to the environment was identified in the risk assessment for the no action alternative (Engineering-Science 1993). The contamination may naturally degrade over time, however, the time cannot be accurately predicted.

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. The no action alternative would not be in compliance with the remedial action objective because of the elevated TPH concentrations. Location specific ARARs do not apply for the Wetland Option.

Long-term effectiveness and permanence: The no action alternative is not directly effective in reducing residual contamination. The contamination may naturally degrade over time, however, this cannot be accurately predicted with available data.

Reduction of toxicity, mobility, or volume through treatment: The no action alternative does not directly reduce the toxicity, mobility, or volume of contaminants through treatment. Eventually most contaminants would diminish.

Short-term effectiveness: Short-term effectiveness is achieved with the no action alternative, because there are no impacts to the community, site workers, and environment resulting from the implementation of this alternative.

Implementability: Technically this alternative is readily implemented, because no action is required. However, administrative implementation may be difficult due to potential lack of regulatory and community acceptance.

Cost: The only cost associated with the no-action alternative if the Wetland Option is pursued is $6,000 to decommission the monitoring wells. There is no groundwater monitoring and no soils treatment.

State acceptance: Regulatory acceptance may be difficult because this alternative would not achieve the TPH cleanup goal of 100 mg/kg through treatment. Regulatory acceptance may be attainable because the contamination may naturally degrade over time, however, the time cannot be accurately predicted.

Community acceptance: Community acceptance may be difficult to obtain due to public perceptions, regarding land use and lack of active treatment of contaminants.

6.6.1.2 S2/S6: Excavation, Capping and Biological Treatment Followed by Solidification/ Stabilization (Aircraft Maintenance-Soils).

Biological treatment of contaminated soil has been proven effective for degrading TPH. Biological treatment consists of excavating contaminated soil and placing this soil in a controlled treatment unit. The soil is aerated either mechanically by tilling the soil or passively through a vent pipe placed in the soil pile. Since the flow rate is very low,

FIGURE 6.6

Evaluation of Soil Remedial Alternatives Wetland Option

Site 7: Aircraft Maintenance Soils

Type of Contaminants	Remedial Alternative Retained for Analysis	Protection of Human Health and the Environment (a)	Compliance with ARARS (a)	Long Term Effectiveness and Perman-ence (a)	Reduction of Toxicity Mobility or Volume Through Treatment (a)	Short-Term Effectiveness (a)	Implement-ability (a)	State Acceptance (b)	Community Acceptance (b)	Present Worth Cost (c) $
TPH and Metals	S1: No Action	◑	◔	◔	○	●	◕	◑	◔	6,000 (d)
	S2/S6/S7: Excav. & Biological Treatment, Solidification/ Stabilization, and Capping (e)	◕	◕	◕	◕	◕	◕	●	●	593,000
	S2/S8/S7: Excav. & Thermal Desorption, Solidification/ Stabilization, and Capping (e)	◕	◕	◕	◕	◑	◕	◕	◑	669,000

LEGEND AND NOTES

(a) Level of Compliance Ranking

- ● High level of compliance
- ◕ Moderate level of compliance
- ◑ Partial level of compliance
- ◔ Low level of compliance
- ○ No level of compliance

(b) Level of Acceptance

- ● High level of acceptance
- ◕ Moderate level of acceptance
- ◑ Partial level of acceptance
- ◔ Low level of acceptance
- ○ No level of acceptance

(c) Cost Range Calculated in Appendix D, 1993 Dollars

(d) No Action Assumes No Groundwater Monitoring. Decommission Wells

(e) A Treatability Study is Recommended to Determine the Effectiveness of Alternative.

REV. 4 C336-19.DWG 05/06/94

emissions control would not be necessary. Aeration stimulates the metabolism and growth of indigenous microorganisms that degrade the contaminants in the soil. Nutrients or special microorganisms can also be added to enhance the remediation process. The areas exceeding 10 mg/kg TPH would then be covered with fill material. A process flow diagram is shown in Appendix E.

Upon completion of the bioremediation, solidification additives are mixed with the soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization would be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposed of in a landfill.

The sequence of activities that would be performed upon implementation of this alternative consist of the following:

- Construction of the treatment unit (possibly including vent pipe and blower)
- Excavation of contaminated soils exceeding 100 mg/kg TPH and placement in treatment unit
- Application of nutrients and micro-organisms if needed
- Tilling of soils or drawing air through soil piles
- Biodegradation of contaminated soils
- Soil sampling to monitor contaminant degradation progress
- Application of solidification agents
- Application of 3 feet of non-engineered fill to soils exceeding 10 mg/kg TPH
- Regrade site

Protection of human health and the environment: No risk to the environment was identified in the risk assessment (Engineering-Science 1993).

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established. Bioremediation has been proven to be an effective treatment for the remediation of TPH contamination in soil and solidification/stabilization would immobilize the beryllium and the arsenic. Under favorable conditions the remedial action objective may be attained. Applying 3 feet of cover material satisfies the sediment criteria for nickel at Aircraft Maintenance.

There are no locations specific ARARs for the Wetland Option.

All the action specific ARARs that apply to excavation and biotreatment and solidification/stabilization would be met with proper technology implementation. Action specific ARARs include excavation, stockpiling, air emissions, land treatment, applying cover pit on-site, and placement of treated soil. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the

soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to a be RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are treated with a specific treatment technology or until constituent concentrations are reduced below specific levels.

Long-term effectiveness and permanence: Bioremediation followed by solidification/stabilization would be protective in the long-term because most of the TPH would be degraded in the soil and immobilizing the metals. Covering the soil contaminated with TPH (above 10 mg/kg) would be protective because the cover would serve as a substrate for plant life and would act as a barrier to exposure to biota.

Reduction of toxicity, mobility, or volume through treatment: Bioremediation followed by solidification/stabilization would reduce the toxicity, mobility, and volume of the TPH and metals contamination.

Short-term effectiveness: Site workers may be exposed to a low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Remedial objectives could be achieved in approximately two years.

Implementability: Bioremediation followed by solidification/stabilization and then covering areas with fill is readily implemented as there are proven technologies, components are commercially available, and can be reliably operated.

Cost: Remediation of soils contaminated with TPH greater than 100 mg/kg at the Aircraft Maintenance Area involved excavating and treating 660 cubic yards of soil. Approximately 68,600 cubic yards of cover material 3 feet high would be applied. The estimated cost for this alternative and the assumptions used are presented in Table DF-7.1.2. The capital cost is estimated to be $547,000 and the annual costs an estimated to be $26,000 per year. The present worth cost is estimated to be $592,000 assuming a two year project life and ten percent annual interest rate.

There are no groundwater monitoring costs associated with the Wetland Option.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating TPH contamination in soil.

Community acceptance: Community acceptance should be attainable because public perceptions regarding active treatment of contaminants and the reduction of long-term risk to the groundwater should be favorable.

6.6.1.3 S2/S8: Excavation, Capping and Low Temperature Thermal Desorption Followed by Solidification/Stabilization (Aircraft Maintenance-Soils)

Low temperature thermal desorption is a thermal separation process designed to remove organic contaminants from soil, sediments, and sludges. The process begins by excavating the contaminated soil and processing it through a rotary dryer used to heat the

contaminated materials and drive off water and organic contaminants. Feed rates, residence times, and temperatures (500 to 800° F) can be adjusted to remove TPHs, VOCs, or SVOCs.

The volatilized gases driven from the soil are collected by a gas treatment system. The gas treatment system typically includes a scrubber and heat exchangers to condense the organic compounds and water vapors. The remaining gas is then cleaned by passing through carbon absorption filters. A process flow diagram is shown in Appendix E.

Treatment residuals include treated soils, liquids from the condensed gas, and spent carbon. Treated soils can be used as fill material and placed back in the excavated area. Both the organic phase liquid condensate and the spent carbon will require further treatment and disposal. The areas exceeding 10 mg/kg TPH would then be covered with fill material.

Upon completion of the thermal desorption, solidification additives are mixed with the soil. The solidification additives immobilize contaminants by incorporating them into the structure of a stable, relatively nonleachable, and non-degradable soil matrix. Prior to selecting the solidification additives, extensive analytical and physical characterization would be performed to ensure compatibility and effectiveness. Following treatment, and after the solidified mixture has passed the TCLP test, it can be returned to the excavation on site or disposed of in a landfill.

The sequence of activities that would be performed in this alternative consist of the following:

- Construction of the treatment unit and soil storage pads
- Excavation of contaminated soils exceeding 100 mg/TPH and transport to storage pad
- Screening all material larger than 2 inches from soil
- Shredding material larger than 2 inches
- Conveying soils to processing system
- Transferring treated soil to storage pad for temporary storage
- Sampling treated soil to monitor contaminant removal
- Applying 3 feet of non-engineered fill the soils exceeding 10 mg/kg TPH
- Regrading the site
- Off-site recycling/disposal of organic phase liquid condensate and the spent carbon

Protection of human health and the environment: No risk to the environment was identified by the risk assessment (Engineering-Science 1993).

Compliance with ARARs: A cleanup goal for TPH (100 mg/kg) has been established to provide protection of the underlying groundwater. Low temperature thermal desorption has been proven to be an effective treatment for the remediation of TPH contamination in soil. Solidification/stabilization would immobilize the metals. Under favorable conditions

the remedial action objective may be attained. Applying 3 feet of cover material satisfies the sediment criteria for nickel at Aircraft Maintenance.

Action specific ARARs that apply to low temperature thermal desorption and solidification/stabilization include excavation, stockpiling, compacting, air emissions, applying cover fill on-site, and placement of treated soil. All action specific ARARs may be met with proper technology implementation.

Location specific ARARs do not apply for the Wetland Option.

With proper technology implementation, action specific ARARs that apply to low temperature thermal desorption would be met. Action specific ARARs include excavation, stockpiling, air emissions, on site replacement of treated soil, and compaction. These requirements may require compliance to RCRA waste levels if the soil is determined to be a RCRA waste. For the soil to be classified as a RCRA waste, the soil contaminants must be either a listed hazardous waste or be a characteristic waste (TCLP characteristic of a hazardous waste). Additionally, if the soil is determined to be a RCRA waste, RCRA land disposal restrictions will apply. Land disposal restrictions require that hazardous wastes not be disposed into or onto land until the hazardous constituents are treated with a specific technology or until constituent concentrations are reduced below specific levels. Lead concentrations are of particular concern.

Long-term effectiveness and permanence: Low temperature thermal desorption would be protective in the long-term because most of the TPH would be removed from the soil. Covering the area containing TPH (above 10 mg/kg) would serve as a substrate for plant life and would act as a barrier to exposure to biota.

Reduction of toxicity, mobility, or volume through treatment: Low temperature thermal desorption followed by solidification/stabilization would reduce the toxicity, mobility, and volume of the TPH and metals contamination.

Short-term effectiveness: Site workers may be exposed to low levels of contaminants during excavation, material handling, and treatment. However, with engineering controls and personal protection equipment the technology can be implemented effectively. Air emissions must be monitored and controlled. Remedial objective could be achieved in approximately one year.

Implementability: Low temperature thermal desorption followed by solidification/stabilization and covering areas with fill is readily implemented since they are proven technologies, components are commercially available, and thermal desorption can be reliably operated. Administrative implementation may be difficult due to local air permitting and anticipated public resistance to thermal processes.

Cost: Remediation of soils contaminated with TPH at Aircraft Maintenance involves excavating and treating 660 cubic yards of soil. The estimated cost for this alternative and assumptions used are presented in Table DF-7.1.3 in Appendix D. Capital costs are estimated to be $669,000. The present worth cost is the same as the capital cost assuming a four month project life. There are no groundwater monitoring costs associated with the Wetland Option.

State acceptance: Regulatory acceptance should be attainable due to this technology's proven effectiveness in remediating soil contaminated with TPH and metals.

Community acceptance: Community acceptance may be somewhat difficult because of public perception regarding thermal treatment process.

6.6.2 Sediment Contamination

Several analytes detected in the sediment samples exceed the no-cover sediment screening criteria including lead, nickel, manganese, zinc, and PAHs and hydrocarbon concentrations range from 230 mg/kg to 2,500 mg/kg. Manganese concentrations are less than background. Table 2.6 summarizes these chemicals of concern. The sediments are found at the base of the concrete storm drain vaults and in the drainage channel. It is possible that contaminants may have infiltrated through cracks that may be present in the storm drain lines. The option of applying 3 feet of cover material to the vaults is not viable and only the no-cover criteria is used for comparison. These are the same analytes identified in the non-flooding scenario. Alternatives for treating the sediments have already been evaluated in Section 4.7.2. These alternatives include sealing each of the storm drains, other connections to the storm drain system, and the outfall pipe. The estimated cost is $45,000 and assumptions are presented in Table D.7.2.4 in Appendix D.

The drainage channel has been assigned to Operable Unit 2 and additional investigation will be conducted to characterize the nature and extent of contamination. The only sediment requiring remediation in the drainage channel based on the EI is TPH. Additional investigation by the Corps of Engineers found metals present as well. Sediments in the channel exceed the no-cover criteria because of the metals present and the channel requires that three feet of fill be applied. The alternative for treating the sediments in the drainage channel are identical to those discussed in Section 4.7.2.

Costs are summarized in Tables DF-7.2.1 through DF-7.2.3. Remediation of sediments contaminated with TPH involves excavating and treating 2,220 cubic yards of sediment and applying 3,330 cubic yards of fill. The estimated cost for biotreatment followed by solidification/stabilization and assumptions used are presented in Table DF-7.2.2 in Appendix D. Capital costs are estimated to be $358,000 and annual costs are estimated to be $92,000 per year. The present worth cost is estimated to be $518,000 assuming a two year project life and ten percent annual interest rate. The estimated cost for thermal desorption and assumptions used are presented in Table DF-7.2.3 in Appendix D. Capital costs and present worth costs are estimated to be $847,000.

SECTION 7

CONCLUSIONS

This section presents the conclusions of the detailed remedial alternatives evaluation conducted for soil and groundwater media at each site. The alternatives for each site were developed and evaluated for effectiveness, implementability, and cost (Section 3). Those alternatives that were retained after the screening evaluation phase were evaluated in further detail in Sections 4, 5, and 6 for the Development Option soil alternatives, groundwater alternatives, and the Wetland Option alternatives, respectively. The alternatives are considered relative to the nine evaluation criteria established to address CERCLA requirements.

Since the full extent of contamination and contaminant cleanup goals have not been established for several sites at HAA, the BRAC property is being considered as two operable units. A proposed plan will be developed from this Alternatives Assessment for sites included in Operable Unit 1 based on the findings of the Final EI Report (Engineering-Science 1993), the supplement to the Final Environmental Investigation (Corps 1994) and results of other investigations by the Corps of Engineers. Conclusions in this Alternatives Assessment are based on information known to date. Sites in Operable Unit 1 that have been studied in the EI/AA include the POL Area (Site 1), Burn Pit (Site 2), Revetment Area (Site 3), Former Sewage Treatment Plant (Site 5), East Levee Landfill (Site 6), Aircraft Maintenance Area (Site 7), soils and sediments in the concrete vaults, the Fuel Lines (Site 8) piping and soil immediately around the piping, and Building 442 (Site 9).

Operable Unit 2 consists of sites for which issues have not yet been resolved and alternatives assessment could not be completed at this time and sites for which remedial action cannot be completed in the same time frame as OU-1. OU-2 includes the entire Pump Station Area (Site 4) soil and sediments, all of the perimeter ditch sediments including those adjacent to the Aircraft Maintenance Area (Site 7), and any excess contaminated soil that may remain after removal of the Fuel Lines (Site 8).

The evaluations of alternatives and costs for the Pump Station Area (Site 4) and the perimeter ditch portion of the Aircraft Maintenance Area (Site 7) have been retained in this AA Report for OU-1, although these areas have been assigned to OU-2. The alternatives assessment for the Pump Station ASTs and soil stockpile is complete. However, the assessment for the Pump Station wetland sediments and the perimeter ditch sediments is incomplete. The volumes of contaminated sediment and cleanup standards

have not been established; therefore, additional investigations and analyses will need to be conducted to complete an AA for sites in Operable Unit 2.

Regulatory agencies have determined that for the Development Option for OU-1 a soil TPH cleanup goal of 10 mg/kg will generally apply. Site-specific exceptions have been made based on immobility, isolation of contaminants from potential receptors, and distance from surface water bodies. The most notable case is the POL Area where a TPH cleanup goal of 100 mg/kg has been approved for soil and bedrock. For the Wetland Option for OU-1, a soil and sediment TPH cleanup goal of 100 mg/kg has been approved by the DTSC and SFRWQCB, provided that three feet of clean cover soil is placed over locations known to contain TPH concentrations greater than 10 mg/kg but less than 100 mg/kg. A general groundwater cleanup goal for TPH of 50 µg/L has been determined. Supporting correspondence is provided in Appendix J. A well decommissioning plan will be prepared for all wells affected by remedial excavations and will follow established well decommissioning standards such as the Geotechnical Requirements for Wells (USATHAMA 1987).

The conclusions of the detailed evaluation, including identification of one or more preferred alternative(s) for the Development Option, are presented for each of the nine sites in Sections 7.1 through 7.9 with subsections on soil and groundwater. Section 7.10 discusses the potential for a centralized soil treatment alternative for Sites 2 through 8. Sections 7.11 through 7.17 present the conclusions of the alternatives analysis for the Wetland Option. Tables 7.1 and 7.2 summarize the alternatives and present worth cost estimates for soil and groundwater respectively, assuming the Development Option. Table 7.3 summarizes the present worth cost estimate assuming the Wetland Option.

The first four alternatives listed in Table 7.1, Soil Flushing (In/Flush), Bioremediation (In/Biorem), Soil Vapor Extraction (In/SVE), and Bioventing (In/Biovent) are in-situ remediation technologies. The remaining soil alternatives require excavation and treatment. The costs estimated in Table 7.1 and 7.3 are based on the estimated volume of soil that requires treatment. Confirmation sampling during remediation could result in more soil being treated and thus increase the cleanup cost. The groundwater remediation cost estimates in Table 7.2 could change, depending on results from required future groundwater monitoring at the POL Area and the FSTP. Results of the Corps of Engineers' supplemental groundwater sampling (Corps 1994) confirmed the findings of the EI and indicate no impact to the cost estimates and preferred alternatives for groundwater remediation for the Pump Station and for the FSTP.

The No Action costs in Tables 7.1 and 7.2 (Development Option) involve up to 30 years of groundwater monitoring. A variation of the No Action alternative is considered at several sites. This variation consists of decommissioning wells, one time collection of free water from remedial excavations, and/or limited groundwater monitoring. The costs for soil remedial alternatives in Table 7.1 do not include groundwater monitoring. However, groundwater monitoring costs are included in the groundwater remedial alternatives in Table 7.2. If either soil or groundwater remediation takes place it has been assumed for the purpose of cost estimating that groundwater monitoring would continue for 20 years or less at some sites. The calculations for 20 years of monitoring costs are

Table 7.1

Present Worth Cost Summary - Soil and Sediment Remediation
Hamilton Army Airfield - Development Reuse Option

	Site	Volume yd³	No action(1) S1	Capping S2	In/Flush S3	In/Bio S4	In/SVE S5	In/Biov S10	Bio S6	Desorp S8	Bio/SS S6/S7	Des/SS S8/S7	TD/SS S9/S7	ChOx/SS S11/S7	Wash S12	Bio/W S6/S12	Des/W S8/S12
1	POL (TPH)	20,490	562,000		1,007,000	867,000		267,000									
2	Burn Pit, beneath pad (TPH)	3,350	1,000			245,000	223,000	141,000	206,000								
	Burn Pit, perimiter of pad (TPH)	2,590						141,000	165,000	537,000							
3	Revetment (TPH)	66,000	1,500						2,252,000	11,487,000							
4	Pump Station, AST-5 (TPH)	180	2,500						47,000	76,000							
	Pump Station, AST-6 (TPH, SVOCs, metals)	180											412,000	161,000			
	Pump Station, AST-7 (TPH, metals)	300									115,000	152,000					
	Pump Station, stockpile (TPH)	710							111,000	171,000							
	Pump Station, all sediments (TPH, pesticides, metals)	22,220											54,105,000	6,102,000	5,675,000		
5	FSTP Drying Beds(TPH, pesticides, PCB, metals)	1,200	41,000										2,696,000	362,000	403,000		
6	East Levee Landfill (TPH)	5,000	7,500						395,000	1,034,000							
7	Aircraft Maintenance, soil at sto. area 2 & 4 (TPH, metals)(3)	1,940	525,000								906,000	1,258,000			1,044,000	1,041,000	1,308,000
	Aircraft Maintenance, storm drain sediment (TPH, SVOCs, metals)(4)	10											45,000				
	Aircraft Maintenance, perimeter ditch sediment (TPH, metals)	2,220									518,000	847,000					
8	Fuel Lines (TPH)	3,190	0						171,000	905,000							
9	Building 442	0	0														
	Centralized Treatment sites 2, 3,4 (AST-5, Stockpile) and 8 (TPH)	76,000							2,604,000								
	Centralized Treatment sites 4 (AST-7) and 7 (TPH and metals)	2,240									1,006,000						

Abbreviations:

Capping	Capping or Encapsulation
In Situ Methods	
In/Flush	Soil Flushing (in situ)
In/Bio	Bioremediation (in situ)
In/SVE	Soil Vapor Extraction (in situ)
In/Biov	Bioventing (in situ)
Excavation Methods	
Bio	Biological Treatment
Desorp	Low Temperature Thermal Desorption
Bio/SS	Biological Treatment followed by Solidification/Stabilization
Des/SS	Low Temperature Thermal Desorption followed by Solidification/Stabilization
TD/SS	Off-site Thermal Destruction followed by Solidification/Stabilization
ChOx/SS	Chemical Oxidation followed by Solidification/Stabilization
Wash	Soil Washing
Bio/W	Biotreatment followed by Soil Washing
Des/W	Low Temperature Thermal Desorption followed by Soil Washing

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☐ = Preferred Alternative

Notes: (1) Refer to Table 7.2 for explanation of No Action cost alternative.

(2) Costs may change if the extent of contamination is greater than that assumed.

(3) Remedial costs include 3 feet of cover material.

(4) Remedial action includes sealing of storm drains.

Table 7.2
Present Worth Cost Summary - Groundwater Remediation
Hamilton Army Airfield - Development Reuse Option

	Site	Flow Rate	No action GW1	20 years Monitoring	Biostim GW2	Carbon GW4	Trtmt. Plant GW4	Biotrt GW5	UV/Oz GW6
1	POL, AST-2 Site	20 gal/day	562,000$^{(1)}$	510,000	696,000	676,000	176,000	714,000	
2	Burn Pit		1,000$^{(2)}$	458,000					
3	Revetment Area		1,500$^{(3)}$	450,000					
4	Pump Station Area		2,500$^{(2)}$	482,000					
5	FSTP	5 gpm	40,800$^{(4)}$	499,000		606,000			
6	East Levee Landfill		7,500$^{(3)}$	467,000					
7	Aircraft Maintenance Area	0.1 gpm	525,000$^{(1)}$	477,000		641,000	323,000	641,000	877,000
8	Fuel Lines		0$^{(5)}$	194,000					
9	Building 442		0$^{(5)}$						

Abbreviations:

Biostim	Biostimulation
Carbon	Carbon Adsorption
UV/Oz	UV/Ozone
Biotrt	Biological treatment
Trtmt. Plant	Gravity feed or batch and transport to Landfill 26 treatment plant in the POL Area (carbon adsorption)

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[box] = Preferred Alternative

Notes: (1) No Action cost includes 30 years groundwater monitoring; treatment alternatives include: 20 years monitoring.

(2) Includes one-time pumpoff of free water from remedial excavations at the Burn Pit, and Pump Station AST sites. No groundwater monitoring is required. Well decommissioning cost included.

(3) No Action cost assumes no monitoring and decomissioning wells outside the area of remedial soil excavation. The cost for decomissioning wells in the area of excavation is included with the soil remedial alternatives.

(4) The Regional Water Quality Control Board agreed that 1 year of groundwater monitoring would be sufficientaction for the FSTP area if contamination abates. The cost includes decommissioning of the wells outside the area of remedial investigation.

(5) No action cost assumes no groundwater monitoring.

Table 7.3
Present Worth Cost Summary - Soil and Sediment Remediation
Hamilton Army Airfield - Wetland Reuse Option

	Site	Volume yd³	No action S1	Bio S6/S2	Desorption S8/S2	Bio/SS S6/S7/S2	Desorp/SS S8/S7/S2	TD/SS S9/S7/S2	Ch Ox/SS S11/S7/S2	Wash S12/S2
1	POL, AST-2 (TPH) (1)	20,490	562,000							
2	Burn Pit (TPH)	3,390	1,000 (3)	217,000	716,000					
3	Revetment Area (TPH)	23,500	0 (4)	1,593,000	5,324,000					
4	Pump Station, stockpiles and AST-5 soil (TPH, PAHs)	810	1,000 (3)	129,000	281,000					
	Pump Station, AST-7 soil (TPH, metals)	210				111,000	127,000			
	Pump Station and AST-6 (TPH and PAHs)	160						397,000	158,000	244,000
	Pump Station, sediments AST-6 (TPH, PAHs, pesticides, metals)	22,220						54,105,000	6,102,000	5,675,000
5	FSTP (TPH, pesticides, PCB, metals)	1,200	31,000 (5)					2,697,000	367,000	408,000
6	East Levee Landfill (TPH and lead)	280	7,500 (6)			165,000	183,000			
7	Aircraft Maintenance, soil storage areas 2 & 4 (TPH)(7)	660	6,000 (6)			592,000	669,000			
	Aircraft Maintenance, perimeter ditch sediment (TPH)	2,220	0 (4)			518,000	847,000			
	Aircraft Maintenance, storm drain sediment (TPH, PAHs, metals)(2)	10						45,000		
8	Fuel Lines (TPH and lead)	670	0 (4)			251,000	285,000			
9	Building 442	0	0 (4)							
	Centralized Treatment sites 2, 3, and 4 (AST-5, stockpile) (TPH)	27,700		1,712,000						
	Centralized Treatment sites 4 (AST-7), 7 (soil), and 8 (TPH and metals)	1,540				817,000				

Abbreviations:

	Excavation and Treatment Methods
Bio	Biological treatment and capping
Desorption	Low Temperature Thermal Desorption and capping
Bio/SS	Biological treatment followed by Solidification/Stabilization and Capping
Desorp/SS	Excavation and Low Temperature Thermal Desorption followed by Solidification/ Stabilization and Capping
TD/SS	Excavation and Off-site Thermal Destruction followed by Solid./Stab. and Capping
Ch Ox/SS	Excavation and Chemical Oxidation followed by Solidification/Stabilization and Capping
Wash	Excavation and Soil Washing and Capping

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☐ = Preferred Alternative

Notes: (1) POL area not affected by Wetland Reuse Option. Refer to Table 7.1 and 7.2.
(2) Alternatives are same as for Development Option. Refer to Table 7.1.
(3) Assumes one time collection of free water from remedial excavation(s).
(4) Assumes no groundwater extraction, well decommissioning, or soil remediation.
(5) Assumes one year groundwater monitoring.
(6) Cost includes decommissioning of monitoring wells.
(7) Remedial alternative should be combined with GW alt. (Table 7.2) for total cost.
(8) Costs may change if the extent of contamination is greater than assumed.

presented in Appendix D, Tables DWM-1 through DWM-8. The total cost for remediation of a site would be the selected soil remedial alternative plus the selected groundwater alternative.

7.1 SITE 1: DEVELOPMENT OPTION - POL AREA

The POL Area is included in Operable Unit 1. For both soil and groundwater, the public health risk assessment indicates very low risk to human health and the ecological risk assessment indicates no risk to the environment resulting from the contaminants identified at this site (Engineering-Science 1993, Section 5). Based on the Board's non-degradation policy, the SFRWQCB has identified a soil TPH cleanup goal of "ND" or 10 mg/kg for HAA (Smith 1992 and Gregg 1994). However, much of the TPH contamination at the POL site is confined in bedrock fractures, making a 10 mg/kg TPH cleanup goal difficult to attain. An alternate TPH cleanup goal of 100 mg/kg has been allowed by the Board for the POL Area based on the presence of fractured bedrock near the ground surface, low potential for remediation of bedrock, and distance from surface water bodies (Page 4 of letter from J. Gregg, SFRWQCB to B. Marcotte, DTSC, 7 March 1994, see Appendix J).

The Final EI Report presents evidence supporting the view that groundwater in the POL Area should not be considered of beneficial use as a potable water source by virtue of insufficient yield. Although beneficial uses for groundwater at HAA have not been identified, MCLs were used as a basis to compare technology effectiveness.

7.1.1 Soil

Remedial alternatives retained for soil at this site after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S3: In-situ Soil Flushing
- S4: In-situ Bioremediation
- S10: In-situ Bioventing

Conclusions from the detailed evaluation of for the retained alternatives (summarized in Figure 4.2) are presented below.

The No Action alternative will not actively protect groundwater, but would rely on natural attenuation and passive remediation to degrade the contamination while slow extraction of groundwater removes the mobile contaminants. The No Action soil alternative is recommended.

None of the alternatives ranked high in the evaluation. Soil Flushing may mobilize contaminants. In-situ Bioremediation and Bioventing may require field pilot tests if remediation by these techniques were applicable. The three remedial alternatives are difficult to implement and may not meet ARARs uniformly throughout the contaminated area. The effectiveness of the three in-situ treatment alternatives in bedrock and tight soil formations such as at the POL Area is uncertain and implementation maybe difficult. If

remediation is required, the two alternatives to consider would be In-situ Bioventing and In-situ Bioremediation, both of which require a field pilot test. The estimated cost to implement Bioventing is about half that of Bioremediation; however, the estimated costs do not include the cost of treatability studies.

There is very low human health risk and no environmental risk associated with the pathways investigated in the EI (Engineering-Science 1993). Therefore, the No Action alternative is currently effective in protecting human health and the environment. Furthermore, if soil contaminants were to migrate to the underlying groundwater, low risks to human or environmental receptors would be anticipated due to extremely low permeability rock and soil (Engineering-Science 1993). A groundwater monitoring program would be implemented to ensure that migration is limited.

In-situ Bioremediation would be difficult to control under the site conditions, because the low permeability sub-surface materials would inhibit the uniform distribution of oxygen and nutrients. An extensive infiltration system would need to be installed to better control the process and deliver oxygen and nutrients to the contaminated soil and rock at a depth of 14 to 17 feet bgs. Bioventing is difficult to control because of the low permeability nature of the soil and the fracture controlled permeability of the rock at the site. In-situ Bioventing tends to remediate only those areas where air can permeate. This is dependent on the size and direction of fissures in the rock. Effectiveness in meeting the TPH cleanup goal will be limited to localized soils reached by the venting air. Nevertheless, it is anticipated that bioremediation may produce an overall reduction of the TPH contaminants nearest the infiltration wells.

In-situ Soil Flushing, like In-situ Bioremediation, is also difficult to implement at this site. The low permeability subsurface materials would require an extensive infiltration system to deliver the washing solution to the contaminated soil and rock at a depth of 14 to 17 feet. Additionally, because the washing solution mobilizes contaminants from the soil matrix and carries the contaminants through the soil profile to groundwater, the system requires groundwater extraction and treatment. The low hydraulic conductivity of the rock and soil would make groundwater extraction very slow and difficult as discussed in Section 7.1.2.

7.1.2 Groundwater

Remedial alternatives retained for the POL Area after evaluation in the screening stage (Section 3.3) are as follows:

- GW1: No Action
- GW2: In-situ Biostimulation
- GW4: Extraction Carbon Adsorption
- GW5: Extraction Biological Treatment

Results of the detailed evaluation for groundwater at this site (summarized in Figure 5.1) are presented below.

Beneficial uses for POL Area groundwater were not identified, thus no ARARs could be identified. However, the SFRWQCB's non-degradation policy would require that TPH concentration in groundwater be cleaned up to background concentrations if feasible and a cleanup goal of 50 µg/L TPH has been determined by the SFRWQCB [see appendix J, letter from J. Gregg (SFRWQCB) to M. Alix (Corps)]. The CRL for TPH (100 µg/L) was used as a screening criterion. None of the potential exposure pathways evaluated in the risk assessment are complete to human or environmental receptors; therefore, no risk is determined to result from POL Area groundwater. The potential for treatment of POL groundwater has been discussed in conjunction with leachate collection and treatment for Landfill 26 (Goldsmith 1991).

The No Action alternative assumed costs associated with 30 years of groundwater monitoring, and was estimated to be the lowest relative cost alternative of the four evaluated alternatives. If no beneficial uses could be assured then the No Action alternative would be recommended. If remediation is required, then either extraction and treatment by Carbon Adsorption or Biological Treatment is recommended. A treatability study is recommended for the preferred alternative in order to evaluate the effectiveness in treating bis(2-ethylhexyl)phthalate, which has been detected in the groundwater.

The In-situ Biostimulation Alternative is difficult to implement. Unlike the other two treatment alternatives, this alternative does not involve groundwater extraction, but it does require permeable soils for oxygen and nutrients to be effectively mixed in groundwater. The presence of low-permeability materials in the saturated zone indicates Biostimulation may only be effective near the injection well, and overall reduction in groundwater contaminants may not be achievable.

The Carbon Adsorption and Biological Treatment alternatives are difficult to implement. Both alternatives require the successful extraction of groundwater for treatment. Groundwater extraction is not easily implemented in low permeability soil and rock. The estimated flow rates from the wells are anticipated to be extremely low, in the range of 3 to 4 gallons per day for each well. Assuming that six wells can contain the plume, the overall extraction rate from the site is approximately 20 gallons per day. If the groundwater extraction could be maintained, both Carbon Adsorption and Biological Treatment could be effective in treating the contaminants. Both of these alternatives were ranked high relative to other evaluation criteria. Since a treatment plant for Landfill 26 utilizing a carbon treatment system has been constructed in the POL Area approximately 300 feet from the AST-2 site, the selection of the carbon alternative would realize further cost saving by collecting the groundwater and piping it by gravity feed to the treatment plant.

The evaluation of all four alternatives is made without reference to ARARs or guidance on the beneficial use of groundwater. Moreover, the fact that no migration pathways are complete leads to the conclusion that there are no risks to human health or environmental receptors (Engineering-Science 1993).

7.2 SITE 2: DEVELOPMENT OPTION - BURN PIT

The Burn Pit is included in Operable Unit 1. The site has two distinct portions, the soil directly beneath the pad and the soil around the perimeter of the pad. Because of the differences in the physical setting between the two areas, remedial action alternatives were evaluated separately. The EI determined that the risk to human health is very low and that there is no risk to the environment.

7.2.1 Soil

Beneath Pad

Remedial alternatives retained for this site for the Development Option after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S4: In-situ Bioremediation
- S5: In-situ Soil Vapor Extraction
- S6: Excavation and Biological Treatment
- S10: In-situ Bioventing

Results of the detailed evaluation for this site (summarized in Figure 4.4) are presented below. The preferred alternative is Excavation and Biological Treatment. In-situ Bioremediation and In-situ Bioventing are ranked closely behind.

Although there is low risk to human health and no environmental risk, the No Action alternative is not preferred because it would not directly treat the contaminants at the site and therefore would not meet the cleanup goal for TPH (10 mg/kg). The contaminants may degrade naturally, but the time required for this natural attenuation cannot be accurately predicted.

In-situ Bioremediation is one of the better alternatives for this site. In-situ Bioremediation is capable of remediating the TPH contamination to meet the cleanup goal of 10 mg/kg. Implementation of the alternative will be difficult due to the low permeability soils at the site, but the contamination is in the shallow soils beneath the pad which consist of a slightly more permeable backfill material. With an extensive infiltration system, oxygen and nutrients can be supplied to the contaminated soils. A field pilot test study would be recommended if this alternative were selected.

In-situ Soil Vapor Extraction is not the preferred alternative due to difficulties in implementation. This alternative requires the successful extraction of volatilized contaminant vapors. Soil Vapor Extraction is likely to be inhibited by several unfavorable site conditions. These conditions include low permeability soils and potential short circuits that would allow vapor to escape through the gravel fill that underlies the Burn Pit pad, and the potential for shallow groundwater (approximately 8 feet below ground surface) to rise and infiltrate the extraction wells.

Bioventing may be more cost effective than Soil Vapor Extraction. Air would be blown in or drawn through the soils at a relatively low flow rate (compared to vapor

extraction flow rates) in order to provide oxygen and stimulate biodegradation. However, the potential for the groundwater to rise and obstruct venting wells could create problems. Bioventing is the least expensive alternative considered. A pilot test study is needed to confirm the effectiveness of Bioventing at the Burn Pit.

Excavation and Biological Treatment ranks slightly better than In-situ Bioventing and the estimated cost is slightly higher. However, excavation and treatment reduces cleanup time significantly and eliminates many of the uncertainties in achieving the TPH cleanup goal and other potential problems associated with in-situ technologies at this site. Excavation and Biological Treatment is the preferred alternative.

Perimeter of the Pad

Remedial alternatives retained for this site for the Development Option after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6: Excavation and Biological Treatment
- S8: Excavation and Low Temperature Thermal Desorption
- S10: In-situ Bioventing

Results of the detailed evaluation for this site (summarized in Figure 4.5) are presented below. The preferred alternative identified for the perimeter of the pad is Excavation/Biological Treatment.

The No Action alternative is not preferred because it will not directly treat the contaminants at the site nor meet the cleanup goal for TPH (10 mg/kg).

Both Excavation/Biological Treatment and Excavation/Thermal Desorption would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. Biological Treatment is selected as the preferred alternative based on the cost savings. However, Thermal Desorption would require less time to remediate the site. Both technologies require treatability studies to confirm their effectiveness at attaining cleanup goals.

In-situ Bioventing is not the preferred alternative, because it is less effective than the selected above ground alternatives. In-situ alternatives have the potential for not providing substantial uniform remediation of the contaminated soils.

7.2.2 Groundwater

Groundwater at the Burn Pit exceeds the 100 μg/L TPH detection limit in three of five samples based on only one round of sampling. No other analytes exceed groundwater cleanup criteria. At the present time, no groundwater remediation is recommended. Regulatory agencies have determined that for remedial excavations such as at the Burn Pit, a one-time removal and treatment of free water from the excavation will be sufficient action for groundwater. This variation of the No Action alternative, which includes the

one-time removal of free water and no further groundwater monitoring, is the preferred alternative.

7.3 SITE 3: DEVELOPMENT OPTION - REVETMENT AREA

The Revetment Area is included in Operable Unit 1. The site contains soil with TPH detections above 100 mg/kg. The EI determined that the risk to human health is very low and that there is no risk to the environment.

7.3.1 Soil

The soil remedial alternatives retained for this site for the Development Option after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6: Excavation and Biological Treatment
- S8: Excavation and Low Temperature Thermal Desorption

Results of the detailed evaluation for this site (summarized in Figure 4.7) are presented below.

Both Excavation/Biological Treatment and Excavation/Thermal Desorption were evaluated to be high in fulfilling the nine evaluation criteria. Both technologies are capable of meeting the TPH cleanup goal. Biological Treatment is the preferred alternative and the cost is less than for Thermal Desorption; however, Thermal Desorption would require less time.

The No Action alternative is not preferred because it will not directly treat the contaminants at the site or meet the cleanup goal for TPH (10 mg/kg).

7.3.2 Groundwater

Manganese was identified in the groundwater at concentrations exceeding the secondary MCL of 50 µg/L. The groundwater in the area is naturally high in salts and minerals typical of sea water. Since no beneficial use of groundwater has been determined at the site, the No Action alternative is selected for groundwater. Since primary MCLs are not exceeded, no further monitoring is recommended. This is considered appropriate because experience in the EI indicates that groundwater monitoring the Revetment Area is impractical due to very low permeability and slow recharge rates in wells.

7.4 SITE 4: DEVELOPMENT OPTION - PUMP STATION

The Pump Station site has been included in Operable Unit 2 and additional investigations will be conducted in the tidal wetland portion of the site to determine the extent of contamination. Based on information from the Final EI Report (Engineering-Science 1993), three separate areas have been identified within the Pump Station site. This is due to differences in the physical setting and the chemicals detected at each of these areas. The three areas include AST locations, the soil stockpile, and sediments. The stockpile includes the unnumbered UST and AST near the pile on the north side of

Building 41. Remedial action alternatives were evaluated separately for each of these areas within the Pump Station site.

7.4.1 Soils and Sediment

AST Areas

Remedial alternatives retained for this site for the Development Option after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6: Excavation and Biological Treatment
- S8: Excavation and Low Temperature Thermal Desorption
- S6/S7: Excavation and Biological Treatment followed by Solidification/ Stabilization
- S8/S7: Excavation and Low Temperature Thermal Desorption followed by Solidification/Stabilization
- S9/S7: Excavation and Off-site Thermal Destruction Incineration followed by Solidification/Stabilization
- S11/S7: Excavation and Chemical Oxidation followed by Solidification/ Stabilization

Results of the detailed evaluation for this site (summarized in Figure 4.10) are presented below. Biological Treatment and Thermal Desorption are effective for treating TPH contaminated soils at AST-5. Thermal Destruction and Chemical Oxidation both followed by Solidification Stabilization are considered for treating soils contaminated with TPH, benzo(a)pyrene, beta-benzene hexachloride, and lead at AST-6. Biological Treatment for Thermal Desorption each followed by Solidification/Stabilization are effective in treating soil contaminated with TPH and zinc at AST-7.

Excavation/Biological Treatment and Excavation/Thermal Desorption are considered for treating TPH contaminated soil at AST-5 because these technologies have been proven to be successful in remediating TPH. Biological Treatment is the preferred alternative and would cost less than Thermal Desorption, but Thermal Desorption would require less time to remediate the site. Similarly, Biological Treatment followed by Solidification/Stabilization (preferred alternative) or Thermal Desorption followed by Solidification/Stabilization would be good candidates for remediating soil contaminated with TPH and metals at AST-7. A treatability study is recommended if either technology is selected to determine if the 10 mg/kg cleanup goal for TPH can be met.

For soils contaminated with TPH, benzo(a)pyrene, beta-benzene hexachloride, and lead at AST-6, Excavation/Off-site Thermal Destruction followed by Solidification/ Stabilization is the preferred alternative because the soil volume is relatively low and the technology ranks high for all of the evaluation criteria. The cost is about three times higher than the cost for Chemical Oxidation followed by Solidification/Stabilization.

However, an advantage of Thermal Destruction technology is that it would eliminate future liability that could be associated with soil treatment and disposal.

Excavation/Chemical Oxidation followed by Solidification/Stabilization is not preferred for this site because it has not been proven to be successful in remediating beta-benzene hexachloride or benzo(a)pyrene. Chemical Oxidation would require a treatability study.

No Action is also not preferred at any of the AST sites because it will not directly treat the contaminants at the site, meet the remedial action objective for TPH (10 mg/kg), nor reduce the low human health risk identified at the site.

Stockpile

Remedial alternatives retained for the soil stock pile after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6: Excavation and Biological Treatment
- S8: Excavation and Low Temperature Thermal Desorption

Results of the detailed evaluation for this site (summarized in Figure 4.11) are presented below.

Both Excavation/Biological Treatment and Excavation/Thermal Desorption were considered for treating the stockpile soil, because they have high potential to fulfill the evaluation criteria. They are both capable of remediating the TPH contamination to the cleanup goal of 10 mg/kg and will reduce the low risks present at the site. Biological Treatment is the preferred alternative and the cost is less than the cost for Thermal Desorption. However, Thermal Desorption would require a shorter remediation time. A treatability study is recommended for either technology if selected to determine whether the TPH cleanup goal can be met.

The No Action alternative is not preferred because it will not directly treat the contaminants at the site nor meet the remedial action objective for TPH (10 mg/kg).

Sediment

The tidal wetland area of the pump station remains wetland under either reuse option and is part of Operable Unit 2. Sediments in the tidal wetlands are contaminated with TPH, metals and pesticides (DDT, DDE, DDD). Remedial alternatives retained for this site after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S2/S6/S7: Excavation, Capping and Biological Treatment followed by Solidification/Stabilization
- S2/S8/S7: Excavation, Capping and Low Temperature Thermal Desorption followed by Solidification/Stabilization

- S2/S9/S7: Excavation, Capping and Off-site Incineration followed by Solidification/Stabilization
- S2/S11/S7: Excavation, Capping and Chemical Oxidation followed by Solidification/Stabilization
- S2/S12: Excavation, Capping and Soil Washing

Results of the detailed evaluation for this area are summarized in Figure 4.12. Biological Treatment and Thermal Desorption followed by Solidification/Stabilization had been considered for treating soils at the south end of the drainage channel contaminated with TPH and metals. However, additional studies by the Army Corps of Engineers indicate that even the southern sediments contain SVOCs. Volume estimates were revised based on Corps of Engineers data (Corps 1994). The remaining alternatives are considered for treating soils also contaminated with pesticides.

Excavation/Soil Washing and Excavation/Chemical Oxidation followed by Solidification/Stabilization were considered for treating the sediment. However, both alternatives require treatability studies to evaluate effectiveness. If the treatability study indicates that neither technology is effective, then Off-Site Thermal Destruction followed by Solidification/Stabilization would satisfy ARARs and would be selected. The cost for Thermal Destruction and Solidification/Stabilization for the estimated 22,220 cubic yards of (entire drainage channel at the Pump Station) soil is roughly five times greater than Soil Washing or Chemical Oxidation alternatives. The area excavated will be covered with 3 feet of fill material if needed to comply with SFRWQCB sediment screening criteria.

The No Action alternative is not preferred because it will not directly treat the contaminants at the site, meet the cleanup goal for TPH (100 mg/kg for wetland with cover), nor provide permanent protection of human health and the environment.

7.4.2 Groundwater/Surface Water

Manganese was identified in the groundwater at concentrations which exceed its secondary MCL of 50 µg/L. The groundwater in the area is naturally high in salts and minerals typical of sea water. The only beneficial use of groundwater identified at the site by the SFRWQCB is replenishment of surface water. The Final EI Report supports the contention that this occurs intermittently and only to a minor extent in the perimeter ditch. The Corps of Engineers performed supplemental groundwater sampling of three temporary monitoring wells and the existing well in the Pump Station Area (Corps 1994). The anayses confirmed that groundwater is not impacted.

A variation of the No Action alternative is recommended. This would involve a one-time collection of free water from the remedial soil excavations and no groundwater monitoring. Regulatory agencies have determined that for remedial excavations such as at the Pump Station AST locations, a one-time removal of free water from the excavation will be sufficient action for groundwater.

Arsenic in the surface water south of AST-7 was identified by the ecological risk assessment as a potential risk (Engineering-Science 1993). Because this area was

sampled at the same time as the FSTP samples were collected, these results were reported and discussed in the EI as part of the Former Sewage Treatment Plant. AST-7 is in fact located adjacent to Pump Station Building 41. The surface water contamination is due to nearby soil contamination left from a leaky fuel tank that has been removed and will be indirectly remediated if a soil remediation alternative is implemented by excavating and treating the soil near the pond. It is recommended that the water which replenishes the pond be monitored for one year after excavation to confirm that the surface water is no longer contaminated.

7.5 SITE 5: DEVELOPMENT OPTION - FORMER SEWAGE TREATMENT PLANT

The Former Sewage Treatment Plant site is included in Operable Unit 1. Results of the EI found low levels of organics in the soils at the area of the former sludge drying beds (Engineering-Science 1993). Beryllium, arsenic, and PCBs exceeded PRGS. Two additional analytes were identified by the human health carcinogenic risk assessment that require remediation: aldrin and DDD. Chromium requires remediation based on the hazard index for non-carcinogenic risks. The environmental risks at the site are ranked high. Additional analytes identified by the environmental risk assessment include mercury, DDT, and DDE.

7.5.1 Soils

Remedial alternatives retained for this site for the Development Option after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S8/S7: Excavation and Thermal Destruction followed by Solidification/ Stabilization
- S11/S7: Excavation and Chemical Oxidation followed by Solidification/ Stabilization
- S12: Excavation and Soil Washing

Results of the detailed evaluation for this site (summarized in Figure 4.15) are presented below. The alternatives are considered for treating the soils contaminated with TPH, pesticides, PCB, and metals in and near the former sludge drying beds.

For treating soils contaminated with pesticides, both Excavation/Soil Washing and Excavation/Chemical Oxidation followed by Solidification/Stabilization are the preferred alternatives. However, both alternatives require treatability studies to evaluate effectiveness. If the treatability studies indicate that neither alternative is effective, then Off-site Thermal Destruction followed by Solidification/Stabilization would satisfy ARARs and would be selected. The cost for Thermal Destruction for the estimated 1,200 cubic yards of soil is approximately six times more expensive than the cost for the Soil Washing or Chemical Oxidation alternatives.

The No Action alternative is not preferred because it will not directly treat the contaminants at the site, meet the soil cleanup goal for TPH (10 mg/kg), or provide permanent protection of human health and the environment.

7.5.2 Groundwater

Volatile organic compounds including benzene were identified in the monitoring well at the FSTP in one round of sampling. Remedial alternatives retained for this site after screening (Section 3.3) are as follows:

- GW1: No Action
- GW2: Carbon Adsorption

Concentrations of VOCs were close to MCLs and the risk to human health and the environment from the groundwater is very low. The No Action alternative with one year of quarterly groundwater monitoring is recommended at this time and this has been tentatively approved by the SFRWQCB and DTSC. The source of contamination will be removed as part of the soil remedial activities. The threat to groundwater and to the environment would be reduced. The groundwater will be monitored quarterly for one year. If the results are still favorable, then groundwater monitoring will be discontinued and the well decommissioned.

The Corps of Engineers performed supplemental groundwater sampling of four temporary monitoring wells and the existing well at the FSTP (Corps 1994). The analyses confirmed the groundwater contaminants and general concentration levels found in the EI. Therefore, the cost estimates and preferred alternative for the FSTP are supported by this initial round of monitoring.

7.6 SITE 6: DEVELOPMENT OPTION - EAST LEVEE LANDFILL

The East Levee Landfill is included in Operable Unit 1. The site contains isolated detections of TPH above 100 mg/kg. The EI determined that the risk to the environment is low. Regulatory agencies have determined that no further action is appropriate for the East Levee Landfill. Supporting correspondence is provided in Appendix J. The East Levee Landfill is likely to remain a tidal wetland regardless of the selection of base reuse option.

7.6.1 Soil

Remedial alternatives retained for this site for the Development Option after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6: Excavation and Biological Treatment
- S8: Excavation and Thermal Desorption

Results of the detailed evaluation for this site (summarized in Figure 4.16) are presented below.

The No Action alternative has been accepted by regulatory agencies because no groundwater contamination is present and TPH contamination is sporadic and relatively low. No Action at East Levee involves no soil remediation and no groundwater monitoring. The monitoring wells need to be decommissioned.

Both Excavation/Biological Treatment and Excavation/Thermal Desorption are effective in treating soils contaminated with TPH and both ranked high for all the evaluation criteria. The cost for Biological Treatment is less than Thermal Description, however, Thermal Description would require less time. A treatability study is recommended if either technology is selected.

7.6.2 Groundwater

Manganese, chloride and fluorides were identified in the groundwater at concentrations which exceed their California secondary MCLs of 50 µg/L, 250,000 µg/L, and 1,800 µg/L, respectively. However, groundwater at the site is naturally high in salts and minerals typical of sea water. Since no beneficial use of groundwater for human consumption has been identified at the site and ecological ARARs have not been exceeded the No Action groundwater alternative is recommended.

7.7 SITE 7: DEVELOPMENT OPTION - AIRCRAFT MAINTENANCE AREA

The Aircraft Maintenance site was divided into three media units, soil, sediment and groundwater for the detailed evaluation. The perimeter drainage ditch is included in Operable Unit 2. The remainder of the Aircraft Maintenance site is part of Operable Unit 1. Different technologies were considered for each of the media in order to address the contaminants unique to each. Regulatory agencies have determined that an appropriate measure to isolate the fill containing traces of beryllium and other metals from contact with humans and environmental receptors, is placement of 3 feet of clean fill over unpaved areas of the Aircraft Maintenance Area. The clean cover fill is required regardless of the selected base reuse option.

7.7.1 Soil

The entire Aircraft Maintenance Area lies upon 3 to 4 feet of imported gravelly backfill which is underlain by Bay Mud soils. The majority of the area is paved (Engineering-Science 1993). Soil contaminants in the backfill include TPH and beryllium near Storage Area 2; arsenic and beryllium near Storage Area 3; and beryllium throughout the site. The arsenic and beryllium were identified in the human health risk assessment. No analytes were identified in the ecological risk assessment. Some tentatively identified compounds in the general family of VOCs are also sporadically distributed in "hot spots" at Storage Areas 2 and 4 in this area.

Remedial alternatives retained for the Development Option soil at this site after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S2: Capping

- S6/S7/S2: Excavation, Biological Treatment followed by Solidification/ Stabilization, and Capping
- S6/S12/S2: Excavation, Biological Treatment followed by Soil Washing, and Capping
- S8/S7/S2: Excavation, Thermal Desorption followed by Solidification/ Stabilization, and Capping
- S8/S12/S2: Excavation, Thermal Desorption followed by Soil Washing, and Capping
- S12/S2: Excavation, Soil Washing, and Capping
- S7: Excavation and Solidification/Stabilization

Results of the detailed evaluation for this site (summarized in Figure 4.19) are presented below.

Capping involves applying 3 feet of non-engineered fill over the unpaved areas at the site. The cost for applying 68,600 cubic yards of soil is approximately $274,000. Applying 3 feet of cover material is included with each of the alternatives considered at Aircraft Maintenance except for S7 (Solidification/Stabilization).

Both Excavation/Biological Treatment and Excavation/Thermal Desorption followed by Solidification/Stabilization and Capping rank high for the first eight evaluation criteria. The combination of organic contaminant treatment and Solidification/Stabilization was preferred over Soil Washing because Soil Washing is not as promising with respect to protection of human health and short-term effectiveness. Biological Treatment is the preferred alternative and would cost less than Thermal Desorption; however, remediation by Biological Treatment would take longer to complete. The TICs in the soil could affect treatment effectiveness. The TICs should be better defined and it is likely that a treatability test is needed to optimize the remedial design for either Biological Treatment or Thermal Desorption. Both alternatives include providing 3 feet of soil cover over the area. The cover material would provide a barrier against exposure of humans and environmental receptors to the beryllium present in the existing fill.

The Solidification/Stabilization alternative and the Capping alternative are evaluated in order to address the beryllium concentrations throughout the backfill as well as the small area at Storage Area 3 (AM-SB-5), which has arsenic and beryllium. The affected soil volume (assuming only the top two feet of backfill is excavated) is 148,000 cubic yards and the cost to remediate is approximately 22 million dollars. It is possible that the source of the backfill material is naturally high in beryllium and arsenic. If only the area near AM-SB-5 is excavated, then an estimated 1,000 cubic yards and soil would be solidified. The estimated cost to treat this smaller volume by solidification/stabilization is $17,000.

7.7.2 Sediment

The volume of contaminated sediments in the concrete vaults is estimated to be about ten cubic yards and is contaminated with elevated concentrations of TPH, SVOCs and metals. The sediment in the perimeter drainage ditch is contaminated with TPH and metals. Supplemental investigations by the Army Corps of Engineers (Corps 1994) found SVOCs in the sediment as well.

Remedial alternatives retained for sediments at this site after evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6/S7: Excavation and Biological Treatment followed by Solidification/ Stabilization
- S8/S7: Excavation and Thermal Desorption followed by Solidification/ Stabilization
- S9/S7: Off-site Thermal Destruction followed by Solidification/Stabilization

Results of the detailed evaluation for this site (summarized in Figure 4.22) are presented below.

The perimeter ditch is part of Operable Unit 2. A revised alternative analysis is recommended once the environmental investigation is complete. No preferred alternatives have been selected at this time.

For sediments that have collected at the base of the storm water concrete vaults, off-site Thermal Destruction is the preferred alterative. The storm drains and the discharge pipe would be sealed to isolate the storm system from water infiltration. This action is required regardless of future base reuse.

7.7.3 Groundwater

The only beneficial use for groundwater identified by the SFRWQCB is replenishment of surface water. The Final EI Report supports the contention that this occurs intermittently and only to a minor extent in the perimeter ditch at the site. The Final EI Report also presents evidence supporting the view that the groundwater at the Aircraft Maintenance Area should not be considered as a potable water source by virtue of insufficient yield and brackish quality. However, MCLs were used as a basis to identify potential analytes that may require treatment and to evaluate technology effectiveness. Four analytes exceeding MCLs were identified in the groundwater samples from the Aircraft Maintenance Area: benzene, manganese, chromium, and beryllium. Assuming four extraction wells and a shallow cutoff wall or trench or collection sumps are installed to contain the plume, the expected flow rate is 0.1 gpm.

Remedial alternatives retained for groundwater at this site after evaluation in the screening stage (Section 3.3) are as follows:

- GW1: No Action
- GW4: Precipitation followed by Carbon Adsorption

- GW5: Precipitation followed by Biological Treatment
- GW6: Precipitation followed by UV/Oxidation

Both Carbon Adsorption and Biological Treatment combined with Precipitation are effective in treating the contaminants identified at the Aircraft Maintenance Area. The cost of the two alternatives are similar. A potential reduction of remediation cost can be realized if the Carbon Adsorption treatment system for Landfill 26 can be used. The preferred alternative is to collect groundwater and then transport it on a batch basis to the Landfill 26 Treatment Plant. However, low flow rates are anticipated, and a piping or trenching delivery system may not be feasible. UV/Oxidation costs are higher than the other alternative costs and is not recommended as a remediation alternative.

7.8 SITE 8: DEVELOPMENT OPTION - FUEL LINES

The Fuel Lines piping and soil immediately adjacent to piping are part of Operable Unit 1. Excess contaminated soil associated with the Fuel Lines will be removed later as an Operable Unit 2 action. Remedial alternatives retained for this site after evaluation for the Development Option in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6: Excavation and Biological Treatment
- S8: Excavation and Low Temperature Thermal Desorption

Results of the detailed evaluation for this site are summarized in Figure 4.24.

Both Excavation/Biological Treatment and Excavation/Thermal Desorption are effective in treating soils contaminated with TPH and rank high for the evaluation criteria. Biological Treatment is the preferred alternative and the cost is less than Thermal Desorption. However, Thermal Desorption would require a shorter remediation time. A treatability study is recommended, if either technology is selected, to determine whether the TPH remediation goal (10 mg/kg) can be met.

The No Action alternative is not preferred because it will not directly treat the contaminants at the site, meet the cleanup goal for TPH (10 mg/kg), or provide permanent protection of human health.

7.9 SITE 9: DEVELOPMENT OPTION - BUILDING 442 AST

Building 442 AST is part of Operable Unit 1. The parcel that includes this site has been cleared by the Army for transfer to the GSA sale property (USAEC 1993a). The only remedial alternative retained for this site after detailed in the screening stage (Section 3.2) is as follows:

- S1: No Action

The No Action alternative fulfills all the evaluation requirements, because no soil contamination above 100 mg/kg TPH was found at this site during the EI. The groundwater is not regarded as a potable water source due to high TDS. Low levels of BTEX were identified in the groundwater by another consultant (H+GCL 1992).

Additional sampling and analyses of soil and groundwater by the Corps of Engineers did not confirm TPHd, TPHjp4, or BTEX in either medium (USAEC 1993).

7.10 DEVELOPMENT OPTION - TRANSFORMERS AND OIL-CONTAINING DEVICES

Transformers and other devices containing PCB are distributed at several locations throughout HAA and are not located in one area. These devices have been grouped as a "site" for discussion in the EI and the AA. Devices containing 50 ppm PCB will be drained and transported off-site for treatment and disposal in accordance with TSCA regulations (40 CFR 761). These regulations require the PCB to be incinerated and the transformers to be triple rinsed and disposed of.

7.11 DEVELOPMENT OPTION - BASE-WIDE CENTRALIZED SOIL TREATMENT AND COST SUMMARY

The bulk of the soil contamination at HAA consists of either TPH (without detectable BTEX) that exceeds the 10 mg/kg cleanup goal or TPH and metals. In the Revetment Area alone, approximately 66,000 cubic yards of soil exceeded the TPH cleanup goal. The volume of soil contaminated with TPH at the Burn Pit, Pump Station (AST-5 and Stockpile), and Fuel Lines combined is approximately 10,000 cubic yards. Soil and rock at the POL site would be difficult to excavate and is not included here. The detailed alternatives evaluation in Section 5 indicated that Excavation and Biological Treatment was a preferred alternative for Sites 2, 3, 4, and 8. Cost savings can be realized if all of the soils to be treated by Biological Treatment are consolidated to a central treatment site. The cost to excavate, transport, and treat soil at one centralized treatment site using Biological Treatment is approximately $2.6 million. The total cost to treat the soil at each site separately is $3.0 million (these costs do not include treatment of soil that required remediation by methods other than Biological Treatment). These costs are summarized in Table 7.1.

A centralized treatment unit to address TPH contamination would result in overall reduction in capital and operating costs. It is recommended for consideration at HAA. Assuming 1) centralized treatment units, 2) no soil remediation at the POL Area, 3) the least expensive preferred alternatives at Pump Station AST-6, AST-7, Pump Station sediments, FSTP, Aircraft Maintenance soils and sediments in the storm drains, and 4) Biological Treatment followed by Solidification/Stabilization is selected for Aircraft Maintenance sediments, then the total present worth cost to remediate the soils at HAA is estimated to be $10.6 million dollars. The cost to treat and/or monitor the groundwater is an additional $0.6 million for a total estimated present worth cost of $11.2 million.

The total cost for sites in Operable Unit 1 only, would be less. The costs to treat soil from the Burn Pit, Revetment Area, and Fuel Lines by Biological Treatment in a centralized treatment unit is $2.6 million. The cost assuming 1) no treatment at POL, 2) the least expensive preferred alternative at the FSTP and Aircraft Maintenance soil, and 3) treating the sediments in the storm drain vaults, is estimated to be $1.3 million. The cost to treat and/or monitor the groundwater is $0.6 million. The total present worth cost

estimate to remediate soil, sediment, and groundwater at the OU-1 sites considered in this AA under the Development Option is $4.5 million dollars.

7.12 WETLAND OPTION

Evaluation of soil remediation alternatives for the Wetland Reuse Option is based on results of the ecological risk assessment, comparison of site contamination levels against wetland sediment screening criteria (Table 2.6), and a soil TPH cleanup goal of 100 mg/kg. Exceptions are the POL Area and the Building 442 site which would be outside the area affected by flooding. Each of the alternatives (except No Action) include covering areas that contain soil concentrations of TPH greater than 10 mg/kg TPH but less than 100 mg/kg with 3 feet of fill.

The basis for identifying contaminants that require remediation under the Wetland Option differs from that for the Development Option. For the Wetland Option, many of the sites require remediation based on a different array of contaminants such as those that exceed the SFRWQCB (1992b) Sediment Screening Criteria and the project-specific nickel sediment criteria (SFRWQCB 1994). There is a range of contaminant concentrations specified in the sediment screening criteria and nickel criteria which does not require that the sediment soil be treated, but does require placement of 3 feet of clean cover material. The following sections discuss the contaminants that would require remediation if the Wetland Option were selected. The preferred remedial alternatives are discussed and the costs for these alternatives are summarized in Table 7.3.

7.13 SITE 1: WETLAND OPTION - POL AREA

Alternatives for the POL are discussed under the Development Option in Section 7.1. The POL Area would not be inundated under the Wetland Option scenario.

7.14 SITE 2: WETLAND OPTION - BURN PIT

The Burn Pit contains soil that is contaminated with TPH above 100 mg/kg. No other contaminants of concern were identified in the ecological risk assessment. The fuel hydrocarbon contamination is confined to six to eight feet of soil immediately beneath the concrete pad and in the shallow soils around the perimeter of the pad. Remediation would require demolition and removal of the pad, excavating the contaminated soils, and covering the remaining area that contains concentrations of TPH between 10 and 100 mg/kg. The one-time removal of free water from remedial excavations is also required (Section 7.2.2).

Remedial alternatives retained are the following:

- S1: No Action
- S6/S2: Excavation, Biological Treatment and Capping
- S8/S2: Excavation, Low Temperature Thermal Desorption and Capping

Results of the detailed evaluation for these sites (summarized in Figure 6.2) are presented below. The preferred alternative is Excavation and Biological Treatment,

followed by Capping. Both Biological Treatment and Thermal Desorption alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than Thermal Desorption. However, Thermal Desorption would require less time to remediate. Areas containing 10 mg/kg or more TPH will be covered.

7.15 SITE 3: WETLAND OPTION - REVETMENT AREA

The Revetment Area contains soils that are contaminated with TPH above 100 mg/kg. No other contaminants of concern were identified in the ecological risk assessment. The Revetment soil locations that exceed 100 mg/kg TPH include pads 17, 20, 16, and 27, and the southern end of the engine test pad. Samples were not collected at pads 9, 11, 12, 23, and 29, and it is assumed that each is contaminated with TPH above 100 mg/kg. All pads except pad 19 and 22 contain soil exceeding 10 mg/kg TPH. Remediation would require excavating the contaminated soils and covering the area containing concentrations of TPH between 10 and 100 mg/kg. One monitoring well will be decommissioned and no groundwater monitoring is recommended.

Remedial alternatives retained are the following:

- S1: No Action
- S6/S2: Excavation, Biological Treatment and Capping
- S8/S2: Excavation, Low Temperature Thermal Desorption and Capping

Results of the detailed evaluation for this site (summarized in Figure 6.2) are presented below. The preferred alternative is Excavation and Biological Treatment followed by Capping. Both Biological Treatment and Thermal Desorption alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than Thermal Desorption. However, Thermal Desorption would require less time to remediate. Areas containing 10 mg/kg or more TPH will be covered.

The No Action alternative is not preferred because it will not reduce the contamination at the site nor meet the cleanup goal for TPH (100 mg/kg).

7.16 SITE 4: WETLAND OPTION - PUMP STATION

The Pump Station Area is assigned to Operable Unit 2 for two reasons: 1) the AST sites cannot be remediated until the final stage of base closure because the pump stations must remain in service; and 2) the tidal wetland has not been fully characterized as to the extent of contamination.

Both sediment and soil at the Pump Station contain analytes that exceed the Sediment Screening Criteria and additional analytes identified as contaminants of concern by the ecological risk assessment. The soil stockpile is contaminated with TPH only and AST-5 soils contain TPH and PAHs which require remediation. AST-6 soils require remediation

for TPH and PAHs, however, the soil around the tank also contains high concentrations of lead, beta-benzene hexachloride and benzo[a]pyrene. Once the soils at AST-6 are excavated, additional treatment may be required in order to comply with land disposal restrictions. AST-7 soils require remediation for TPH and zinc. The sediments outboard of the levee are contaminated with TPH, PAHs, insecticides and metals.

Results of the detailed evaluation are summarized in Figure 6.3. The following alternatives were retained for evaluation:

- S1: No Action
- S6/S2: Excavation, Biological Treatment and Capping
- S8/S2: Excavation, Thermal Desorption, and Capping
- S6/S7/S2: Excavation, Biological Treatment followed by Solidification/Stabilization, and Capping
- S8/S7/S2: Excavation, Thermal Desorption followed by Solidification/Stabilization, and Capping
- S9/S7/S2: Excavation, Off-site Thermal Destruction followed by Solidification/Stabilization, and Capping
- S7/S11/S2: Excavation, Chemical Oxidation followed by Solidification/Stabilization, and Capping
- S12/S2: Excavation, Soil Washing, and Capping

The No Action alternative is not preferred because it will not reduce the contamination at the site nor meet the cleanup goal for TPH (100 mg/kg).

The preferred alternatives are different for each of the subsites within the Pump Station Area because each has a different array of contaminants. The three subsite soil groupings are discussed below:

7.16.1 AST-5 and Stockpile (Pump Station)

The preferred alternatives for the stockpile soil and the soil near AST-5 is Biological Treatment. Both Biological Treatment and Thermal Desorption alternatives can remediate TPH although a treatability study is required to determine the effectiveness both technologies on Pump Station soil. The PAH concentration exceeds the SFRWQCB no-cover Sediment Screening Criteria, and three feet of cover material would be required above the excavated area. The cover material could possibly be treated soil or sediment.

Both alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than for Thermal Desorption; however, Thermal Desorption would require less time to remediate.

7.16.2 AST-7 Soils (Pump Station)

The preferred alternatives for soil at AST-7 is Biological Treatment followed by Solidification/Stabilization. A treatability study is needed to determine how effective this technology is at remediating the contaminants of concern. The excavated area would be covered with 3 feet of cover material.

Either Biological Treatment or Thermal Desorption each followed by Solidification/Stabilization alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than for Thermal Desorption; however, Thermal Desorption would require less time to remediate.

7.16.3 AST-6 Soils (Pump Station)

The preferred alternatives for AST-6 soils are Chemical Oxidation followed by Solidification/Stabilization and Soil Washing. Soil contaminated above the SFRWQCB with-cover Sediment Screening Criteria will be excavated and treated. Soil with contamination that exceeds the SFRWQCB no-cover Sediment Screening Criteria (lower concentrations) but does not exceed the with-cover criteria will be left in place. Three feet of clean fill will be required to cover areas containing TPH greater than 10 mg/kg.

Both alternatives would reduce human health risk, and reduce the toxicity, mobility, and volume of the contamination. Although Chemical Oxidation and Soil Washing are candidates for treating individual contaminants identified at the site, it is uncertain how each of these technologies will perform for the array of contaminants present and with the clay-rich soil present at the site. A treatability study is needed in order to determine the effectiveness of each of the preferred alternatives. The results from the treatability study will be used to better estimate compliance with ARARs and long term effectiveness of each of the preferred alternatives.

7.16.4 Wetland Sediments (Pump Station)

A preferred alternative for the tidal wetland sediments cannot be determined at this time because the full extent of contamination has not been determined and cleanup goals have not been established.

The preferred alternatives for the sediments outboard of the levee are Chemical Oxidation followed by Solidification/Stabilization and Soil Washing. Soil contaminated in excess of the SFRWQCB with-cover Sediment Screening Criteria will be excavated and treated. Sediment with contamination that exceeds the no-cover Sediment Screening Criteria (lower concentrations) but does not exceed the with-cover criteria will be left in place. Three feet of clean fill will be required to cover areas containing TPH greater than 10 mg/kg.

Both alternatives would reduce human health risk, and reduce the toxicity, mobility, and volume of the contamination. Although Chemical Oxidation and Soil Washing are candidates for treating individual contaminants identified at the site, it is uncertain how each of these technologies will perform for the array of contaminants present and with

the sediment present at the site. A treatability study is needed in order to determine the effectiveness of each of the preferred alternatives. The results from the treatability study will be used to better estimate compliance with ARARs and long term effectiveness of each of the preferred alternatives.

7.17 SITE 5: WETLAND OPTION - FORMER SEWAGE TREATMENT PLANT

Soils in the Former Sewage Treatment Plant drying beds area require remediation due to the presence of pesticides and metals at concentrations that exceed the SFRWQCB with-cover Sediment Screening Criteria. Soils in the drying beds also exceed the TPH cleanup goal of 100 mg/kg.

Results of the detailed evaluation are summarized in Figure 6.4. The following alternatives were retained for evaluation.

- S1: No Action
- S7/S9/S2: Excavation, Thermal Destruction followed by Solidification/ Stabilization, and Capping
- S7/S11/S2: Excavation, Chemical Oxidation followed by Solidification/ Stabilization, and Capping
- S12/S2: Excavation Soil Washing, and Capping

The preferred alternatives for soil in the drying beds area at the Former Sewage Treatment Plant are Chemical Oxidation followed by Solidification/Stabilization and Soil Washing. Soil that is left in place which exceeds 10 mg/kg TPH or the no-cover Sediment Screening Criteria require 3 feet of cover material be applied. Quarterly groundwater monitoring is also recommended (refer to Section 7.5.2).

The No Action alternative is not preferred because it will not directly treat the contaminants at the site nor meet the cleanup goal for TPH (100 mg/kg).

Both alternatives would reduce human health risk, and reduce the toxicity, mobility, and volume of the contamination. Although Chemical Oxidation and Soil Washing are candidates for treating individual contaminants identified at the site, it is uncertain how each of these technologies will perform for the array of contaminants present and with the clay-rich soil and sediment present at the site. A treatability study is needed in order to determine the effectiveness of each of the preferred alternatives and to make a selection of one alternative. The results from the treatability study will be used to better estimate compliance with ARARs and long term effectiveness of each of the preferred alternatives.

7.18 SITE 6: WETLAND OPTION - EAST LEVEE LANDFILL

The contaminants identified at the sites are TPH and lead. Results of the detailed evaluation for these sites are summarized in Figure 6.5. Remedial alternatives retained for site evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6/S7/S2: Excavation, Biological Treatment followed by Solidification/ Stabilization and Capping
- S8/S7/S2: Excavation, Thermal Desorption, followed by Solidification/ Stabilization and Capping

The No Action alternative has been accepted by regulatory agencies for the East Levee Landfill because no groundwater contamination is present and TPH contamination is sporadic and relatively low (see Appendix J).

Both Biological Treatment and Thermal Desorption alternatives can remediate TPH and address the lead contamination, although a treatability study is required to determine the effectiveness of the alternatives.

The alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than Thermal Desorption; however, Thermal Desorption would require less time to remediate. Lead concentrations exceeded the SFRWQCB no-cover Sediment Screening Criteria. Three feet of cover material would be required.

7.19 SITE 7: WETLAND OPTION - AIRCRAFT MAINTENANCE AREA

The Aircraft Maintenance Area soils contain TPH and metals and the sediments in the perimeter contain a range of contaminants. Storage Area 2 contains soil that exceeds 100 mg/kg TPH. Contamination appears to be contained in the backfill which is 2 to 4 feet deep. The Capping alternative (S2) was retained for the Aircraft Maintenance Area to provide a barrier against exposure to the beryllium in the existing fill.

The following remedial alternatives retained for evaluation:

- S1: No Action
- S2: Capping (3 feet of cover material)
- S6/S7/S2: Excavation, Biological Treatment, followed by Solidification/ Stabilization and Capping
- S8/S7/S2: Excavation, Thermal Desportion, followed by Solidification/ Stabilization and Capping

Results of the detailed evaluation and presented below. The preferred alternative for the soils is Biological Treatment followed by Solidification/Stabilization. Either Biological Treatment or Thermal Desorption alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than Thermal Desorption; however, Thermal Desorption would require less time to remediate. Unpaved areas at the Aircraft Maintenance Area will be covered with 3 feet of fill. Passive groundwater collection and

treatment is also recommended as well as decommissioning the existing wells (Section 7.7.3).

The No Action alternative is not preferred because it will not reduce the contamination at the site nor meet the cleanup goal for TPH (100 mg/kg).

There are two areas of sediment contamination at the Aircraft Maintenance site, the storm drain sediments and the sediments in the perimeter ditch. The perimeter ditch is included in Operable Unit 2 and the storm drain sediment is part of Operable Unit 1. Based on the EI, the only contaminant detected in the perimeter ditch requiring remediation is TPH. Findings of the Corps of Engineers supplemental investigations (Corps 1994) indicate that contamination is more extensive. No preferred alternatives have been selected at this time.

Approximately 10 cubic yards of sediments are contained in the drain catch basins. These sediments are contaminated with TPH, PAHs, and metals. Alternatives are discussed in Section 4.7.2. The preferred alternative is Thermal Destruction followed by Solidification/ Stabilization and sealing the storm drain system.

7.20 SITE 8: WETLAND OPTION - FUEL LINES

The Fuel Line piping and the soil immediately adjacent to the piping are included in Operable Unit 1. However, excess contaminated soil associated with the Fuel Lines will be part of Operable Unit 2. Results of the detailed evaluation for these sites are summarized in Figure 6.5. The contaminants identified at the sites are TPH and lead. Remedial alternatives retained for site evaluation in the screening stage (Section 3.2) are as follows:

- S1: No Action
- S6/S7/S2: Excavation, Biological Treatment followed by Solidification/ Stabilization and Capping
- S8/S7/S2: Excavation, Thermal Desorption, followed by Solidification/ Stabilization and Capping

The preferred alternatives for soils along the Fuel Lines is Biological Treatment followed by Solidification/Stabilization. Both Biological Treatment and Thermal Desorption alternatives can remediate TPH and address the lead contamination, although a treatability study is required to determine the effectiveness of the alternatives.

Both alternatives would reduce human health risk, achieve compliance with ARARs, provide long term effectiveness and permanence, and reduce the toxicity, mobility, and volume of the contamination. The costs associated with Biological Treatment would be less than Thermal Desorption; however, Thermal Desorption would require less time to remediate. Lead concentrations exceeded the SFRWQCB no-cover Sediment Screening Criteria. Three feet of cover material would be required.

7.21 SITE 9: WETLAND OPTION - BUILDING 442 AST

Building 442 AST is not affected by the Wetland Option and is discussed in Section 7.9.

7.22 SITE 10: WETLAND OPTION - TRANSFORMERS AND OIL-CONTAINING DEVICES

The disposal and treatment of transformers or other devices containing PCB greater than 50 ppm is identical to that discussed for the Development Option (Section 7.10).

7.23 WETLAND OPTION - BASE-WIDE CENTRALIZED SOIL AND SEDIMENT TREATMENT AND COST SUMMARY

Much of the soil requiring remediation at HAA contains TPH as the only contaminant. The total volume of contaminated soil from the Burn Pit, Revetment, and Pump Station AST-5 and stockpile is 27,700 cubic yards. The detailed alternatives evaluation for these sites indicates that Biological Treatment is the preferred alternative. The cost to excavate, transport, and treat soil at one centralized treatment site using Biological Treatment is approximately $1.7 million dollars. The total cost to remediate each of the above sites individually is $1.9 million dollars. These costs are summarized in Table 7.3.

The total present worth cost to remediate soils and sediment assuming the Wetland Option is estimated to be $9.5 million dollars. This cost assumes that 1) a centralized treatment unit is used for TPH-contaminated soil and 2) one of the preferred alternatives is selected for other sites. These other sites include the Pump Station AST-6, AST-7 and Pump Station sediments, FSTP, Fuel Lines, Aircraft Maintenance soil, sediments in the storm drains, and sediments in the perimeter ditch. Also, this cost assumes no soil remedial action at the POL.

The total cost for groundwater alternatives is $0.5 million. This assumes that 1) groundwater at the POL is extracted and treated at Landfill 26 treatment plant, 2) free water is collected and removed one time from remedial excavations at the Burn Pit and Pump Station sites,; and 3) a passive groundwater collection system such as an interceptor trench is installed at the Aircraft Maintenance Area. Alternatives for the POL are discussed under the Development Option in Section 7.1 since it would not be inundated under the Wetland Option.

The total present worth cost for remediation for the sites studied in this AA under the Wetland Option is estimated to be $10.0 million. Costs for sites in Operable Unit 1 only would be less. The cost for centralized treatment for the Burn Pit and the Revetment Area is $1.7 million dollars. The cost for the least expensive alternative for Aircraft Maintenance soil and storm drain sediments, the Fuel Lines, and FSTP is $1.3 million. The groundwater cost is $0.5 million. The total present worth cost estimate for OU-1 is $3.5 million dollars.

SECTION 8

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AA	Alternatives Analysis
ABS	Dermal Absorption Factor
ACMs	Asbestos Containing Materials
AFB	Air Force Base
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Above Ground Storage Tank
Avg	Average
Av-gas	Aviation fuel
BAP	benzo[a]pyrene
BCF	Bioconcentration Factor
BDAT	Best Demonstrated Available Technology
Beta-HCH	Beta Benzene Hexachloride
bgs	below ground surface
BHC	beta-benzenehexachloride
Bldg.	Building
BRAC	base realignment and closure
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
btoc	below top of casing
CADD	Computer-Aided Drafting and Design
CAL EPA	California EPA
CAP	Civil Air Patrol
CDI	Chronic Daily Intake
CEG	Certified Engineering Geologist
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
COC	Chain of Custody
Conc	Concentration
Corps	Army Corps of Engineers
CRL	Certified Reporting Limit
d	Day
DDD	2,2-bis(p-chlorophenyl) - 1,1-dichloroethane

GLOSSARY OF ACRONYMS AND ABBREVIATIONS (continued)

DDT	2,2-bis(p-chlorophenyl) - 1,1-trichloroethane
Decr.	Decreased
DHS	Department of Health Services
DOT	Department of Transportation
DQO	Data Quality Objective
DTSC	Department of Toxic Substance Control, CAL EPA
EHRT	Environmental Health Research and Testing, Inc.
EI	Environmental Investigation
EM	Electromagnetic Method
EPA	US Environmental Protection Agency
EPIX	Environmental Photographic Interpretation Center (USEPA)
ERA	Environmental Risk Assessment
ES	Engineering-Science, Inc.
ESE	Environmental Science and Engineering, Inc.
FID	Flame Ionization Detector
FS	Feasibility Study
FSP	Field Sampling Plan
FSTP	Former Sewage Treatment Plant
ft/day	feet per day
ft/sec	feet per second
GAC	Granular Activated Carbon
GC	Gas Chromatograph
GI	Gastrointestinal
GPM	Gallons per Minute
GPR	Ground Penetrating Radar
GSA	General Services Administration
HAA	Hamilton Army Airfield
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HHEM	Human Health Evaluation Manual
hr	Hour
IA	Installation Assessment
id	inside diameter
Inc.	Increased
Ing.	Ingestion
Inh.	Inhalation
IRDMIS	Installation Restoration Data Management Information System
IRIS	Integrated Risk Information System

GLOSSARY OF ACRONYMS AND ABBREVIATIONS (continued)

IRP	Installation Restoration Program
IT	International Technology Corporation
Jordan	E.C. Jordan Co.
JP-4	Jet fuel No. 4
LLA	Lowest Livable Area
LOAEL	Lowest-Observed-Adverse-Effect-Level
MAX	Maximum
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDL	Method Detection Limit
mg/kg	milligrams per kilogram
mph	miles per hour
M/S	Maintenance and Storage
MSL	mean sea level
NCP	National Contingency Plan
ND	Not Detected
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPL	National Priority List
NPDES	National Pollutant Discharge Elimination System
NOAEL	No-Observed-Adverse-Effect-Level
NOEL	No-Observed-Effect-Level
PA	Preliminary Assessment
PAHs	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
PE	Professional Engineer
PID	Photoionization Detector
PNA	Polynuclear Aromatic Hydrocarbon
POL	Petroleum, Oil and Lubricants
ppm	parts per million
POTW	Publicly Owned Treatment Works
PRG	Preliminary Remediation Goal
PSF	Presidio of San Francisco
PVC	Polyvinyl Chloride
PWC	Public Works Center

GLOSSARY OF ACRONYMS AND ABBREVIATIONS (continued)

QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QCP	Quality Control Plan
RAGS	Risk Assessment Guidance for Superfund
RBC	Red Blood Count
RCRA	Resource Conservation and Recovery Act
REA	Registered Environmental Assessor
RfC	Reference Concentration
RfD	Reference Dose
RG	Registered Geologist
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SDP	Sampling Design Plan
SDWA	State Drinking Water Act
SF	Slope Factor
SFCORPS	San Francisco District U.S. Army Corps of Engineers
SFRWQCB	Regional Water Quality Control Baord, San Francisco Region
Site-ID	Site Identification
SMCL	Secondary Maximum Contaminant Level
SOPs	Standard Operating Procedures
sq. ft.	square feet
STLC	Soluable Threshold Limit Concentration
SVE	Soil Vapor Extraction
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TIC	Tentatively Identified Compound
TP	Technical Plan
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substance Control Act
TTLC	Total Threshold Limit Concentration
USACE	US Army Corps of Engineers
USAF	US Air Force
USATHAMA	US Army Toxic and Hazardous Materials Agency
USCS	United Soil Classification Plan

GLOSSARY OF ACRONYMS AND ABBREVIATIONS (continued)

USGS	US Geological Survey
UST	Underground Storage Tank
UTM	Universal Transverse Mercator
VFH	Volatile Fuel Hydrocarbons
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WCC	Woodward-Clyde Consultants
WQC	Water Quality Criteria
Weston	Roy F. Weston, Inc.
Wk	Week
Wt	Weight
Yr	Year
°F	Degrees Fahrenheit
µg/L	micrograms per liter

SECTION 9

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APPENDIX A

SUMMARY OF CONTAMINATION DATA

APPENDIX A

SUMMARY OF CONTAMINATION DATA

The following tables are obtained from the EI (Engineering-Science 1993) and all table numbers are identical to those in the EI. Concentrations are reported for analytes that exceed their certified reporting limits (CRLs).

APPENDIX A

LIST OF TABLES

Table

APPENDIX A

LIST OF TABLES (continued)

Table

APPENDIX A

LIST OF TABLES (continued)

Table

Table 4.5
POL Area
Analytes Detected in Subsurface Soil (Drill Cuttings Samples)
Phase I Investigation

Analytes	CRL (mg/kg)	101(a)	102	103(a)	104(a)	106	107	108	109	110	111A	112A	113B	113C
Depths (ft):		14.5	5.0	13.0	17.0	16.0	17.0	13.0	11.0	10.0	8.0	8.0	15.0	13.0
		concentrations in mg/kg												
VOCs														
TICs		15		0.4	0.5									28.9
SVOCs														
Bis(2-ethylhexyl)-phthalate	0.480	1.4	3.02	1.43						0.82	1.52	1.01	1.59	
2-Methyl-naphthalene	0.032													0.3
TICs		9.9		0.5	3.8	1							1	23
TPH	10(nc)	113	41.7	39.7	503					16.1	15.9	25		15.1
Lead	0.467	9.2	15.2	9.63	7.11	7.65	7.5	8.25	7.7	5.94	7.72	14.8	9.12	9.24

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration
(nc): non-certified reporting limit
[shaded box]: not detected
NA: not analyzed
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds
(a): air rotary cuttings samples; all other samples were auger cuttings

4_5&7-b.wk1
05/25/93

Table 4.6
POL Area
Analytes Detected in Subsurface Soil
Phase II Investigation

	Sample Loc:	PL-SB-1		PL-SB-2		PL-SB-3	PL-SB-4		PL-SB-5		PL-SB-6		PL-SB-7		PL-SB-8		PL-SB-9	
	Depth (ft):	5.5	7.5	5	10	10	5	7	5	7	5	7	5	7	5	7	5	7
Analytes	CRL (mg/kg)	concentrations in mg/kg																
TPH	10 (nc)							51.4	30.0							20.5		
BTEX	(a)																	

	Sample Loc:	PL-SB-10		PL-SB-11	PL-SB-12	PL-SB-13		PL-SB-14			PL-SB-15		PL-SB-16			PL-MW-114(b)	PL-MW-115(b)
	Depth (ft):	9	10.5	7	7	5	10.5	5	5*	10	10	15	5	5	10	19	19.5
Analytes	CRL (mg/kg)	concentrations in mg/kg															
TPH	10 (nc)	10.4		20.6	20.2			51.4	64.2	72.3		30.6				80.2	401
BTEX	(a)																
Lead	0.467	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.7	16

LEGEND

CRL: USATHAMA certified reporting limit
(nc): non-certified reporting limit
*: duplicate
(shaded): not detected
NA : not analyzed

TPH : total petroleum hydrocarbons
BTEX : benzene, toluene, ethylbenzene, and xylenes
(b) : air rotary cuttings samples; all other samples were split spoon tube samples

(a) : CRLs for BTEX (mg/kg):

benzene	0.0850
toluene	0.190
ethylbenzene	0.160
xylenes	0.390

(see also Appendix D.1)

4_6-tbl1
07/27/95

Table 4.7
POL Area
Analytes Detected in Groundwater
Phase I Investigation

Analytes	CRL (µg/L)	101	103	104	105	105(dup)	106	107	108	109	110	111A	111B	112A	112B	113A	113A(dup)	113C	113C(dup)
		concentrations in µg/L																	
TPH	100(nc)	14,000		580															NA
VOCs																			
Benzene	1.00	9.69																	NA
Ethylbenzene	1.00	210																	NA
Xylene	2.00	371																	NA
1,3 Dimethyl-benzene	1.00	479																	NA
TICs		3,650	4																NA
SVOCs																			
Bis(2-ethylhexyl)-phthalate	7.70	14.7	29.3		22														
2-Methyl-naphthalene	1.30	89																	
Naphthalene	0.50	90.4																	
TICs		1,280																	
Lead	4.47				5.91														NA

LEGEND

- CRL: USATHAMA Certified Reporting Limit concentration
- (nc): non-certified reporting limit
- [shaded]: not detected
- NA: not analyzed
- (dup): duplicate sample
- VOCs: volatile organic compounds
- SVOCs: semi-volatile organic compounds
- TPH: total petroleum hydrocarbons
- TICs: tentatively identified compounds

Table 4.8
POL Area
Detected Analytes in Groundwater Samples
Phase II Investigation

Round 1

Analytes	Sample Loc.: CRL (µg/L)	101	101*	103	104	105	106	107	108	109	110	111A	111B	112A	112B	113A	113C	114	115	115*
		concentrations in µg/L																		
TPH	100 (nc)	3600	4000																	
BTEX																				
Benzene	1.05	6.05	5.79																	
Toluene	1.47	8.01	10.0																	
Ethylbenzene	1.37	110	100																	
Xylene	1.36	290	270																	
1,3-Dimethylbenzene	1.32	280	200																	
Lead	4.47																			

Round 2

Analytes	Sample Loc.: CRL (µg/L)	101	103	104	104*	105	106	107	108	109	110	111A	111B	112A	112B	113A	113C	114	115
		concentrations in µg/L																	
TPH	100 (nc)	11000																	
BTEX																			
Benzene	1.05	6.03														1.46			
Toluene	1.47	4.34														2.21			
Ethylbenzene	1.37	94.0																	
Xylene	1.36	260																	
1,3-Dimethylbenzene	1.32	220																	
Lead	4.47						5.59											6.4	6.13

LEGEND

CRL : USATHAMA certified reporting limit
(nc) : non-certified reporting limit
(shaded box) : not detected
* : duplicate

BTEX : benzene, toluene, ethylbenzene, and xylenes
TPH : total petroleum hydrocarbons

Table 4.9
Burn Pit Area
Analytes Detected in Surface Soil

	Sample Loc:	BP-SS-1	BP-SS-2	BP-SS-3	BP-SS-4	BP-SS-5	BP-SS-5(dup)
Analytes	CRL (mg/kg)	concentrations in mg/kg					
VOCs							
Toluene	0.100	0.26	0.18	0.18		0.24	0.59
TICs							
SVOCs							
Bis(2-ethylhexyl)-phthalate	0.480			1.02	8.79	2.48	1.2
Benzo[A]-anthracene	0.041					0.18	
Chrysene	0.032					0.19	
TICs			2.6	6.7	8.5	36	
TPH	10(nc)	12.9	43.8	123	15.6	346	175
Lead	0.467	20	12	54	13	15	55

LEGEND

CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
(nc):	non-certified reporting limit	VOCs:	volatile organic compounds
[shaded box]:	not detected	SVOCs:	semi-volatile organic compounds
NA:	not analyzed	TPH:	total petroleum hydrocarbons
		TICs:	tentatively identified compounds

Table 4.10
Burn Pit Area
Analytes Detected in Subsurface Soil from Borings and Test Pits

Sample Loc.:		BP-MW-101						BP-MW-102			BP-MW-103				BP-MW-104			BP-TP-1		BP-TP-2	
Depths (ft):		2	4	5.5	7	8.5	14.5	4.5	8	15	5	6.5	10.5	16	6	11	16	0	6	0	5.5
Analytes	CRL (mg/kg)	concentrations in mg/kg																			
VOCs																					
1,3-Dimethyl-benzene	0.230	2.01		0.81																	
Ethylbenzene	0.190	0.7																			
Toluene	0.100	0.59		0.36				0.14	0.52	0.44				0.44		0.28					
Xylene	0.780	1.66																			
Methylene chloride	4.400										4.73				5.16						
TICs		400	158	141					0.4		0.7	0.6				0.4					
SVOCs																					
2-Methyl-naphthalene	0.032	11.2	6.35	6.15																	
Benzo[A]-anthracene	0.041	0.24																			
Fluoranthene	0.032	0.39	0.12	0.15																	
Fluorene	0.065	0.51																			
Naphthalene	0.740	8.59	2.1	3.03																	
Phenanthrene	0.032	0.71	0.94	0.76																	
Pyrene	0.083	0.4																			
Bis(2-ethylhexyl)-phthalate	0.480											2.3		1.55							
TICs		126	66	57		0.9		0.4	2.5		30.3	17	9.1	3.8	2.1		0.3	1.3	0.9	0.7	0.6
TPH	10(nc)	1,920	1,590	850	17.3			20			97.6	190	132					19.7		31.1	
Lead	0.467	NA	10.8	19.3	7.85	8.21	3.65	14.1	8.29	4.32	8.48	6.61	7.22	7.87	7.58	5.13	6.74	8.5	6.6	8.3	9.8

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration
(nc): non-certified reporting limit
[shaded box]: not detected
NA: not analyzed
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds

Table 4.11
Burn Pit Area
Analytes Detected in Groundwater

	Well No.:	BP-MW-101	BP-MW-102	BP-MW-102(dup)	BP-MW-103	BP-MW-104
Analytes	CRL (μg/L)	concentrations in μg/L				
VOCs						
Methylethyl ketone	10.00	25.3	29.9	NA	25.3	29.9
TICs						
SVOCs						
TICs				NA		10
TPH	100(nc)	120	140	110		
Lead	4.47		7.49	NA	9.13	

LEGEND			
CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
(nc):	non-certified reporting limit	VOCs:	volatile organic compounds
[shaded]:	not detected	SVOCs:	semi-volatile organic compounds
NA:	not analyzed	TPH:	total petroleum hydrocarbons
		TICs:	tentatively identified compounds

4_10&11.wk1

12/02/92

Table 4.12
Revetment Area
Analytes Detected in Composited Surface Soil Samples

Pad No.:		1	2	3	4	5	7	8	13	14	15	16	17	18	19	19(dup)	20	21	22	24	24(dup)	25	26	27	28
Analytes	CRL (mg/kg)	concentrations in mg/kg																							
SVOCs																									
Benzo[A]-anthracene	0.041	1.46					0.08										0.24								
Chrysene	0.032	0.14															0.27								
Fluoranthene	0.032	0.19					0.19				0.16					0.13	0.48							0.26	
Phenanthrene	0.032	0.26					0.34				0.29						0.44							0.19	
Pyrene	0.083	0.24					0.15				0.26					0.23	0.78							0.58	
Bis(2-ethylhexyl)-phthalate	0.480			0.98				0.81																	
TICs		7	1.1	1.2	2		0.6	2.4	8.6	21.2	9.3	1.9	7.5	2.1	5.4	6.7	34	0.3		3	0.6	4	0.5	13.4	1.3
TPH	10(nc)	32.5	60.4	17.4	22.9	87.9	11.9	53.6	77.6	19.2	63.5	27.4	97.6	15.8			131	84.9		49.3	14.1	17.4	174	167	19.7
Lead	0.467	36	42	14.7	33	27	12.4	17.4	44	24	14.6	23	14.5	25	41	23	44	20.4	22	18	18	29	24	38	12
"Worst-case" TPH*		162.50	302.00	87.00	114.50	439.50	59.50	268.00	388.00	96.00	317.50	137.00	488.00	79.00	0.00	0.00	655.00	424.50	0.00	246.50	70.50	87.00	870.00	835.00	98.50

LEGEND

CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
(nc):	non-certified reporting limit	VOCs:	volatile organic compounds
[shaded cell]	: not detected	SVOCs:	semi-volatile organic compounds
NA:	not analyzed	TPH:	total petroleum hydrocarbons
		TICs:	tentatively identified compounds

*"worst case" TPH values are 5 times the detected concentration in 5-part composite samples

4_12.wk1

07/19/93

Table 4.13
Revetment Area
Analytes Detected in Soil at Engine Test Pad

		Boring Samples				Test Pit Samples								
	Sample Loc.:	RV-MW-101				RV-TP-1			RV-TP-2			RV-TP-3		
	Depths (ft):	3.5	4.5	5	8.5	0	5.5	6	0	4	5.5	0.25	4	6
Analytes	CRL (mg/kg)	concentrations in mg/kg												
VOCs														
Toluene	0.100								0.21	0.28				
TICs												0.8		
SVOCs														
Bis(2-ethylhexyl)-phthalate	0.480				2.17					0.3	0.6			
TICs							0.3	0.4	2			0.5	0.9	2
TPH	10(nc)								236			44		
Lead	0.467	18.3	12.6	12.4	6.38	9.3	11	11	20	12	12	10	8.3	11

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration
(nc): non-certified reporting limit
[shaded]: not detected
NA: not analyzed
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds

4_13&.wk1

12/02/92

Table 4.14
Revetment Area
Analytes Detected in Subsurface Soil Samples
Phase II Investigation

		Pad 17										Pad 20									
	Sample Loc.:	RV-SB-1			RV-SB-2			RV-SB-3		RV-SB-4		RV-SB-5		RV-SB-6			RV-SB-7		RV-SB-8		RV-MW-103
	Depth (ft):	2	2*	4	2	2*	4	2	4	2	4	3	5	3	5	5*	3	5	3	5	3
Analytes	CRL (mg/kg)	concentrations in mg/kg																			
TPH	10 (nc)	53.3		139	107	54.1		54.3		54	28.7										
BTEX	(a)																				
Lead	0.467	12	12		21	13	15	13	11	11	15	39	22	19	16	10	11.7	7.28	14	7.78	9.91

		Pad 27									Pad 26									
	Sample Loc.:	RV-SB-9		RV-SB-10			RV-SB-11		RV-SB-12		RV-SB-13		RV-SB-14		RV-SB-15		RV-SB-16			RV-MW-102
	Depth (ft):	3	4.5	3	4.5	4.5*	3	5	3	5	2	4	2	4	2	4	2	4	4*	4
Analytes	CRL (mg/kg)	concentrations in mg/kg																		
TPH	10 (nc)			302		11.5										67.1		12.6		
BTEX	(a)																			
Lead	0.467	15	11	29	13	15	17	14	51	26	11.4	6.66	15.9	12.6	10.3	13.5	13.4	12	10.7	18.9

LEGEND

CRL: USATHAMA certified reporting limit
(nc): non-certified reporting limit
*: duplicate of previous sample
[shaded]: not detected
NA : not analyzed

TPH: total petroleum hydrocarbons
BTEX: benzene, toluene, ethylbenzene, and xylenes

(a) : CRLs for BTEX (mg/kg):

benzene	0.0850
toluene	0.190
ethylbenzene	0.160
xylenes	0.390

(see also Appendix D.1)

4_14-b.wk1
[illegible]

Table 4.15
Revetment Area
Detected Analytes in Groundwater Samples

		Round 1, Phase II		Round 2, Phase II		
	Sample Loc.:	101	103	101	101*	103
Analytes	CRL (µg/L)	concentrations in µg/L				
TPH	100 (nc)					
BTEX	(a)					
Lead	4.47			8.8		NA

		Phase I
	Sample Loc.:	101
Analytes	CRL (µg/L)	
VOCs	--	
SVOCs	--	
TPH	100 (nc)	
TPH*	100 (nc)	
Metals §		
Arsenic	2.35	7.28
Barium	2.82	70.50
Calcium	105	230,000
Copper	18.8	30.9
Iron	77.5	489
Lead	4.47	8.23
Magnesium	135	680,000
Manganese	9.67	1,050
Potassium	1240	201,000
Sodium	279	4,500,000
Cyanide	5.0	12.60

LEGEND

CRL: USATHAMA certified reporting limit
(nc): non-certified reporting limit
[shaded]: not detected
*: duplicate
NA : not analyzed
(a) : CRLs for BTEX (µg/L):

benzene	1.05
toluene	1.47
ethylbenzene	1.37
xylenes	1.36

(see also Appendix D.1)

VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
BTEX: benzene, toluene, ethylbenzene, and xylenes
TPH: total petroleum hydrocarbons
§: aluminum, antimony, beryllium, cadmium, cobalt, chromium, mercury, nickel, selenium, silver, thallium, vanadium, and zinc not detected

4_15-b.wk1
05/25/93

Table 4.16
Pump Station Area
Analytes Detected in Surface Soils

	Sample Loc:	PS-SS-1	PS-SS-1*	PS-SS-2	PS-SS-3	PS-SS-4	PS-SS-5	PS-SS-6	PS-SS-7	PS-SS-8
Analytes	CRL (mg/kg)	concentrations in mg/kg								
VOCs										
Toluene	0.100			0.75	0.18	0.22		0.15	0.35	0.15
TICs	—			40	473	1.6	0.9	0.6		0.4
SVOCs										
2,4,6-Trichloro-phenol	0.061					11.2				
2-Methyl-naphthalene	0.032			107						
Acenaphthene	0.041		0.12	5.63	1.07					
Benzo[A]-anthracene	0.041	0.4	10.3		19.6					
Benzo[A]-pyrene	1.20		6.2							
beta-Benzene-hexachloride	1.3			46.1						
Benzo[G,H,I]-perylene	0.180		15.3							
Benzo[K]-fluoranthene	0.130	0.69	14.7							
Chrysene	0.032	0.58	11.5		30.8	1.13	0.06			
Dibenz[A,H]-anthracene	0.310				13.7					
Fluoranthene	0.032	0.33	6.07		31	1.79				
Fluorene	0.065				0.69					
Indeno[1,2,3-C,D]-pyrene	2.4		11							
Naphthalene	0.740			36.9						
Phenanthrene	0.032	0.12	3.19	81.6	49.7	30.5			0.54	
Pyrene	0.083	0.61	6.2	5.41	31					
TICs	—	0.3	8.5	4,100	169.5	2,300	23.6	42	26	52
TPH	10 (nc)	31.9	555	332,000	126	166,000	779	881	1,570	11,100
Lead	0.467	44	42	410	20	14.1	8.84	27	27	23

LEGEND

CRL : USATHAMA certified reporting limit
(nc) : non-certified reporting limit
[shaded] : not detected
* : duplicate sample

VOCs: : volatile organic compounds
SVOCs : semi-volatile organic compounds
TPH : total petroleum hydrocarbons
TICs : tentatively identified compounds

Table 4.17a
Pump Station Area
Organic Analytes Detected in Sediment Samples

		Building 35, North			Building 39, Center			Building 41, South			
	Sample Loc.:	PS-SD-1	PS-SD-4	PS-SD-5	PS-SD-2	PS-SD-6	PS-SD-7	PS-SD-3	PS-SD-8	PS-SD-9	PS-SD-9(dup)
Analytes	CRL (mg/kg)	concentrations in mg/kg									
VOCs											
TICs		870	NA	NA		NA	NA		NA	NA	NA
SVOCs											
Bis(2-ethylhexyl)-phthalate	0.480					2.45	2.8		1.71		
Benzo[A]-anthracene	0.041					0.42	0.49				
Benzo[G,H,I]-perylene	0.180					1.39	1.06				
Benzo[K]-fluoranthene	0.130					0.7	0.87				
Chrysene	0.032					0.67	0.68				
Fluoranthene	0.032	0.17		0.12		0.45	0.61				
Phenanthrene	0.032					0.79	0.6				
DDD	0.064					3.03	0.94				1.43
DDT	0.100	0.25									
Pyrene	0.083	0.2		0.36		0.95	0.95				
TICs		4.1	2.8	3.3		13.3	12.9	2.7	3	3	6
TPH	10(nc)	2,690	NA	NA	1,420	NA	NA	283	NA	NA	NA

LEGEND

CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
(nc):	non-certified reporting limit	VOCs:	volatile organic compounds
[shaded] :	not detected	SVOCs:	semi-volatile organic compounds
NA:	not analyzed	TPH:	total petroleum hydrocarbons
		TICs:	tentatively identified compounds

Table 4.17b
Pump Station Area
Inorganic Analytes Detected in Sediment Samples

		Building 35			Building 39			Building 41			
	Sample Loc.:	PS-SD-1	PS-SD-4	PS-SD-5	PS-SD-2	PS-SD-6	PS-SD-7	PS-SD-3	PS-SD-8	PS-SD-9	PS-SD-9(dup)
Analytes	CRL (mg/kg)	concentrations in mg/kg									
Metals §											
Aluminum	11.2	46,100	60,900	61,200	48,700	53,400	60,300	30,000	70,100	65,900	62,100
Arsenic	2.5*	*	10.3	13.5	*	16.1	13.4	*	11.9	9.52	11.4
Barium	3.29	115	132	127	90.2	165	130	68	145	154	152
Beryllium	0.427	1.62	3.68	3.05	2.17	7.21	4.17	0.91	2.32	2.2	1.75
Boron	6.64	99.4	NA	NA	61.6	NA	NA	41.8	NA	NA	NA
Calcium	25.3	6,120	4,930	4,890	5,380	4,110	5,780	6,510	5,640	5,130	5,300
Chromium	1.04	93.7	115	123	107	234	126	59	142	132	128
Cobalt	2.50	56.1	53	48.3	43.9	94.7	89.3	21.1	55.9	38.3	32.6
Copper	2.84	72.9	78.6	84.4	78.9	131	85.4	37.2	81.9	78.4	77.2
Iron	6.66	61,600	59,800	68,300	64,000	120,000	73,500	40,400	70,500	62,200	62,200
Lead	0.467*	90	60	82	59	890	140	23.3	43	68	79
Magnesium	10.1	15,100	15,500	15,600	17,000	9,080	15,400	9,160	19,100	17,000	16,700
Manganese	9.87	1,640	1,980	1,940	845	4,100	4,700	504	3,000	1,850	1,790
Mercury	0.05		NA	NA		NA	NA		NA	NA	NA
Nickel	2.74	180	218	193	155	265	310	77.7	219	161	139
Potassium	131.0	6,290	7,710	6,940	6,350	6,250	6,550	3,680	8,100	8,360	7,980
Selenium	0.449*	*			*	1.35		*			
Silver	0.803					6.61					
Sodium	38.7	19,600	12,400	8,020	23,400	13,400	6,620	6,270	9,560	13,500	13,800
Vanadium	1.41	93.5	110	112	98.7	66.7	107	64	139	128	124
Zinc	2.34	223	248	234	202	349	287	90.9	215	183	178
Cyanide	0.25		NA	NA		NA	NA		NA	NA	NA

LEGEND

CRL: USATHAMA Certified Reporting Limit Concentration

§: antimony, cadmium, molybdenum, tellurium, thallium, and tin not detected in samples PS-SD-1, -2 and -3; antimony, cadmium, and thallium not detected in samples PS-SD-4, -5, -6, -7, -8, -9, and -9(dup).

(shaded) : not detected

NA : not analyzed

(dup): duplicate sample

*: CRLs for PS-SD-1, -2, and -3 samples: rsenic: 16.4 mg/kg; lead: 7.44 mg/kg; selenium: 20.7 mg/kg.

4_17.wk1

07/27/98

Table 4.18
Pump Station Area
Analytes Detected in Groundwater and Soil from Well PS-MW-101

	Water	
concentrations in µg/L		
Analytes	CRL	Values
VOCs		
Methylethyl ketone	10.0	32.2
SVOCs		
TPH	100(nc)	
Metals §		
Barium	2.82	109
Calcium	105	320,000
Chromium	16.8	32.5
Magnesium	135	700,000
Manganese	9.67	4,360
Nickel	32.1	38.6
Potassium	1240	233,000
Sodium	279	4,500,000
Zinc	18.0	35.8
Cyanide	5.0	18.5
Cyanide*	5.0	10.4

	Soil Samples			
	Depths (ft):	1	2.5	4.5
Analytes	CRL	concentrations in mg/kg		
VOCs				
Toluene	0.100	0.16	0.15	0.57
TICs		0.3		
SVOCs				
TPH	10(nc)			
Lead	0.467	6.36	12	10.3

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration
(nc): non-certified reporting limit
[shaded box]: not detected
*: duplicate sample
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds
§: aluminum, antimony, arsenic, beryllium, cadmium, cobalt, copper, iron, lead, mercury, selenium, silver, thallium, and vanadium not detected.

4_18.wk1 07/19/93

Table 4.19a
Former Sewage Treatment Plant Area
Organic Analytes Detected in Soil and Sediment Samples
Phase I Investigation

		SOIL			SEDIMENT		
	Sample Loc.:	TP-MW-101			TP-SD-1	TP-SD-2	TP-SD-3
	Depths (ft):	1.0	2.5	9.5	0	0	0-2*
Analytes	CRL (mg/kg)	concentrations in mg/kg					
VOCs							
Toluene	0.100	0.27	0.19				
TICs					0.5		NA
SVOCs							
Bis(2-ethylhexyl)-phthalate	0.480	1.72	2.07				
Benzo[A]-anthracene	0.041	0.17					NA
Fluoranthene	0.032	0.19				0.18	
Phenanthrene	0.032					0.12	
TICs		15.7	13.6		45.4	3	

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration

[shaded cell]: not detected

NA: not analyzed

VOCs: volatile organic compounds

SVOCs: semi-volatile organic compounds

TICs: tentatively identified compounds

*: composite of three sample depth intervals

4_19&21.wk1 12/02/92

Table 4.19b
Former Sewage Treatment Plant Area
Inorganic Analytes Detected in Soil and Sediment Samples
Phase I Investigation

		SOIL			SEDIMENT		
	Sample Loc.:	TP-MW-101			TP-SD-1	TP-SD-2	TP-SD-3
	Depths (ft):	1.5	2.5	9.5	0	0	0-2*
Analytes	CRL (mg/kg)	concentrations in mg/kg					
Metals §							
Aluminum	11.2	15,200	23,600	34,500	46,600	16,600	46,200
Arsenic	2.5¤	3.93	3.81	4.48			16.2
Barium	3.29	240	116	51.9	137	112	110
Beryllium	0.427	0.95	1.41	1.46			
Boron	6.64	NA	NA	NA	51.9	34.2	NA
Calcium	25.3	8,140	50,100	5,400	7,100	10,700	10,600
Chromium	1.04	40	51.1	94	92.1	31.5	103
Cobalt	2.5	8.28	10.8	16.5	24.2	7.42	20.6
Copper	2.84	102	37.1	41.4	45.4	17.9	80.4
Iron	6.66	27,300	28,500	52,100	54,500	20,000	54,900
Lead	0.467¤	69	11.8	8.3	19.8		45.8
Magnesium	10.1	4,410	7,770	15,300	11,800	6,260	13,700
Manganese	9.87	283	322	503	3,300	221	583
Mercury	0.05	NA	NA	NA	0.32	0.26	
Nickel	2.74	33.7	42.9	80.7	87.8	28.3	95.9
Potassium	131	1,890	2,220	4,790	5,660	3,420	5,020
Selenium	0.449¤	1.95					
Silver	0.803	9.42					
Sodium	38.7	1,650	2,080	6,540	9,960	16,200	10,500
Vanadium	1.41	33.5	54.5	75.7	96.4	29.8	106
Zinc	2.34	216	57.3	91.7	175	57.7	145
Cyanide	0.25	0.53				0.89	

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration

NA : not analyzed   *: composite of three sample depth intervals

(shaded) : not detected

§: antimony, cadmium, and thallium not detected and molybdenum, tellurium, and tin not analyzed in samples TP-MW-101 and TP-SD-3;
antimony, cadmium, molybdenum, tellurium, thallium, and tin not detected in samples TP-SD-1, and -2.

¤: CRLs for TP-SD-1, and -2 samples: arsenic: 16.4 mg/kg; lead: 7.44 mg/kg; selenium: 20.7 mg/kg.

4_19b21.wk1   07/27/93

Table 4.20a
Former Sewage Treatment Plant, Drying Beds Area
Organic Analytes Detected In Shallow Soil Samples

	Sample Loc.:	TP-SS-1	TP-SS-1	TP-SS-2	TP-SS-3	TP-SS-4	TP-SS-5	TP-SS-6	TP-SS-6	TP-SS-7	TP-SS-8
	Depths (ft):	0.9	0.9*	0.6	0.8	1.0	1.0	1.0	1.0*	1.0	1.0
Analytes	CRL (mg/kg)	concentrations in mg/kg									
VOCs	--										
SVOCs											
2-Methylnapthalene	0.032	0.109									0.076
Bis(2-ethylhexyl)-phthalate	0.48										1.5
Di-n-Butyl phthalate	1.3						1.46				
Phenanthrene	0.032	0.221									
DDD	0.064	1.48	1.05	0.444	1.02						
TICs	—	15.6	3.5	10.3	9.1	4.2	1.6	12.7	1	6.6	22.2
TPH	10 (nc)	210	110	140	230	120	10	140		90	2600

LEGEND

CRL : USATHAMA certified reporting limit
[shaded] : not detected
* : duplicate

VOCs : volatile organic compounds
SVOCs : semi-volatile organic compounds
TPH : total petroleum hydrocarbons
TICs : tentatively identified compounds

4_20
12/08/92

Table 4.20b
Former Sewage Treatment Plant, Drying Beds Area
Organo–Chlorine Pesticides Detected In Shallow Soil Samples

	Sample Loc.:	TP-SS-1	TP-SS-1	TP-SS-2	TP-SS-3	TP-SS-4	TP-SS-5	TP-SS-6	TP-SS-6	TP-SS-7	TP-SS-8
	Depths (ft):	0.9	0.9*	0.6	0.8	1.0	1.0	1.0	1.0*	1.0	1.0
Analytes	CRL (mg/kg)	concentrations in mg/kg									
OCPs/PCBs											
Aldrin	0.0014	0.0155	NA								0.0327
Dieldrin	0.0016	0.005	NA	0.0105	0.0217		0.00441	0.00306	0.00609	0.00435	0.0333
Endrin	0.0065		NA	0.00994	0.0227						0.0165
Endrin Ketone[1]	--		NA			0.00311		0.0025	0.00372	0.00567	
Heptachlor Epoxide	0.0013		NA	0.00417	0.0106		0.00223	0.00311			0.0292
Isodrin	0.003		NA								0.0104
PCB 1254[1]	--	1.05	NA					0.203	0.377	0.209	1.2
DDD	0.0027	0.73	NA	0.504	1.39	0.00506	0.0591	0.0183	0.0404	0.0302	0.0481
DDE	0.0027	0.104	NA	0.0423	0.094		0.00828	0.00394	0.00973	0.00968	0.0688
DDT	0.0035	0.0865	NA	0.112	0.199	0.0168	0.111	0.0467	0.0772	0.0499	0.164

LEGEND

CRL : USATHAMA certified reporting limit

(shaded) : not detected

* : duplicate

NA : not analyzed

OCPs/PCBs : Organo–chlorine pesticides and PCBs

1 : Data not validated

4_20
12/08/92

Table 4.20c

Former Sewage Treatment Plant, Drying Beds Area
Inorganic Analytes Detected In Shallow Soil Samples

	Sample Loc.:	TP-SS-1	TP-SS-1	TP-SS-2	TP-SS-3	TP-SS-4	TP-SS-5	TP-SS-6	TP-SS-6	TP-SS-7	TP-SS-8
	Depths (ft):	0.9	0.9*	0.6	0.8	1.0	1.0	1.0	1.0*	1.0	1.0
Analytes	CRL (mg/kg)	concentrations in mg/kg									
Metals§											
Aluminum	11.2	22,000	28,900	18,800	19,200	3,860	30,400	14,900	15,600	16,900	26,900
Arsenic	2.5	5.87	5.97	4.51	4.3		7.41	2.82	3.03	4.25	4.71
Barium	3.29	240	205	222	232	26.3	127	163	162	148	430
Beryllium	0.427	0.689		0.562	0.631				0.687	0.607	
Boron	6.64	14.2	17.9	12.3	13.4		21.6	11.3	11.2	10.5	17.3
Cadmium	1.2										4.6
Calcium	25.3	6,750	4,990	6,100	4,860	1,080	4,840	5,190	4,010	3,340	13,100
Chromium	1.04	54.9	67	52.5	48.6	10.1	76.9	27.3	29.4	33.9	86.6
Cobalt	2.5	10.9	10.7	8.84	8.33		16.5	6.06	6.89	6.26	9.28
Copper	2.84	58.5	70.8	53.6	60.8	17.5	37.5	29.9	29.6	36.2	128
Iron	6.66	32,400	42,200	27,900	27,400	6,320	37,600	18,100	19,600	20,800	42,900
Lead	0.467	51	53	42	47	9.55	17.1	37	17.9	16.3	76
Magnesium	10.1	6,140	7,630	5,950	5,190	1,100	8,370	3,570	3,830	3,930	6,370
Manganese	9.87	396	289	285	248	54.5	625	191	206	215	284
Mercury	0.05	1.7	1.9	1.2	1.9	0.305	0.433	0.604	0.762	0.538	2.5
Nickel	2.74	42.8	46.6	38.5	33.4	6.79	55	22.4	21.5	24.9	57.7
Potassium	131	2,240	3,220	2,080	2,030	526	2,910	1,810	1,900	1,930	2,120
Silver	0.803	14.5	11.5	10.5	14.3	1.77	2.38	3.74	3.36	2.95	17.2
Sodium	38.7	1,500	1,720	856	759	213	879	264	265	307	358
Tin	7.43	15.8		10.1	15.8						36.2
Vanadium	1.41	45.3	48.9	39.5	40.6	8.64	60.4	24.7	25.7	30.9	53
Zinc	2.34	144	170	127	117	26.8	126	93.3	83.3	80.5	382

LEGEND

CRL : USATHAMA certified reporting limit
(shaded) : not detected
* : duplicate

§ : antimony, molybdenum, tellurium, thallium, and selenium were not detected

Table 4.21a
Former Sewage Treatment Plant Area
Organic Analytes Detected in Water Samples

		MONITORING WELLS		SURFACE WATER		
	Sample Loc.:	TP-MW-101	TP-MW-101(dup)	TP-SW-1	TP-SW-1(dup)	TP-SW-2
Analytes	CRL (μg/L)	concentrations in μg/L				
VOCs						
1,3-Dimethyl-benzene	1.00	2.83	2.72			
Acetone	8.00	198	158			
Benzene	1.00	1.4	1.24			
Chlorobenzene	1.00	20.2	18.3			
Dichlorobenzene	2.00	13.1	12.1			
Toluene	1.00	1.7	1.6			
Methylethyl ketone	10.0	69	75.9			
Methylisobutyl ketone	1.40	9.76	10.8			
Xylene	2.00	3.17	2.87			
TICs		53	23			
SVOCs						
1,4-Dichloro-benzene	1.50	15	13.9			
2-Methyl-naphthalene	1.30	3.72	3.19			
4-Methylphenol	2.80	21.6	21.6			
Naphthalene	0.50	5.23	4.38			
Phenol	2.20	204	232			
TICs		43	77			

LEGEND

CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
(shaded box):	not detected	VOCs:	volatile organic compounds
NA:	not analyzed	SVOCs:	semi-volatile organic compounds
		TICs:	tentatively identified compounds

4_19&21.wk1 12/02/92

Table 4.21b
Former Sewage Treatment Plant Area
Inorganic Analytes Detected in Water Samples

		MONITORING WELLS		SURFACE WATER		
	Sample Loc:	TP-MW-101	TP-MW-101(dup)	TP-SW-1	TP-SW-1(dup)	TP-SW-2
Analytes	CRL (µg/L)	concentrations in µg/L				
Metals §						
Aluminum	112	558				
Antimony	60	101	96.5			
Arsenic	2.35	15.6	15.1	2.93	2.93	6.31
Barium	2.82	144	128	86.3	92.6	200
Beryllium	1.12	1.8				
Calcium	105	1,100,000	980,000	590,000	580,000	630,000
Iron	77.5	396		205	217	
Magnesium	135	3,050	2,630	1,300,000	1,200,000	740,000
Manganese	9.67			1,020	1,100	2,130
Mercury	0.1	0.34	0.12			
Nickel	32.1	57.6				
Potassium	1240	70,900	65,200	220,000	220,000	183,000
Sodium	279	4,600,000	4,500,000	8,900,000	8,000,000	5,700,000
Zinc	18	26.8				
Cyanide	5					
Anions						
Alkalinity bicarbonate		180,000	230,000	NA	NA	NA
Alkalinity carbonate		49,000	49,000	NA	NA	NA
Nitrate,-ite	10	32.1	32.6	53	58	63
Chloride	278	8,000,000	7,400,000	13,000,000	11,000,000	9,900,000
Fluoride	153	NA	NA	42,000	41,000	NA
Sulfate	175	460,000	460,000	1,700,000	1,900,000	1,700,000

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration

NA (shaded) : not analyzed

(shaded) : not detected

(dup): duplicate sample

§: cadmium, chromium, cobalt, copper, lead, selenium, silver, thallium, and vanadium not detected in any samples.

4_19821.wk1

07/27/93

Table 4.22
East Levee Landfill Area
Analytes Detected in Subsurface Soil

Analytes	Sample Loc.: CRL (mg/kg)	EL-MW-101	EL-MW-102	EL-MW-103	EL-MW-104
		concentrations in mg/kg			
VOCs					
TICs			0.6		
SVOCs					
Bis(2-ethylhexyl)-phthalate	0.480			3.09	
TICs		12.5		0.3	0.4
Anions					
Nitrate,-ite	1.00	3.59	3.17	3.09	14.8
Chloride	7.12	12,000	7,500	10,000	2,700
Sulfate	175	2,300	1,500	1,400	330
Metals §					
Aluminum	11.2	54,100	38,200	30,200	25,800
Arsenic	2.5	13.1	8.2	12.5	5.3
Barium	3.29	91	78.5	68.3	171
Beryllium	0.427	2.09	1.69	1.64	1.61
Cadmium	1.2				4.96
Calcium	25.3	3,110	3,870	2,610	8,720
Chromium	1.04	127	98.3	72.7	101
Cobalt	2.5	15.1	16.5	19.4	15.8
Copper	2.84	65.4	43	51.2	78
Iron	6.66	62,300	56,400	33,600	51,800
Lead	0.467	52	18.5	43	96
Magnesium	10.1	13,500	12,600	9,680	9,200
Manganese	9.87	250	456	274	505
Nickel	2.74	87.3	72.6	63	64.5
Potassium	131	4,820	4,860	3,290	4,180
Silver	0.803				2.06
Sodium	38.7	11,900	7,680	8,150	1,930
Vanadium	1.41	130	88	74	57.9
Zinc	2.34	97.8	101	92.7	327
Cyanide	0.25				

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration

[shaded box]: not detected

§: antimony, selenium and thallium not detected in any samples; and mercury not analyzed.

VOCs: volatile organic compounds

SVOCs: semi-volatile organic compounds

TICs: tentatively identified compounds

4_22&23.wk1 07/19/93

Table 4.23
East Levee Landfill Area
Analytes Detected in Groundwater

Analytes	Sample Loc.: CRL (µg/L)	EL-MW-101	EL-MW-102	EL-MW-103	EL-MW-104	EL-MW-104(dup)	EL-MW-105
		concentrations in µg/L					
VOCs							
Methylethyl ketone	10.0	27.6					
SVOCs							
Anions							
Alkalinity bicarbonate		2,600,000	NA	NA	NA	NA	NA
Nitrate,-ite	10.0	66.5	51	57	66	55	65
Chloride	278	11,000,000	11,000,000	12,000,000	15,000,000	16,000,000	20,000,000
Fluoride	153	6,400,000	30,000	3,100,000	NA	46,000	51,000
Sulfate	175	110,000	82,000	110,000	62,000	NA	680,000
Metals §							
Aluminum	112	137				NA	239
Arsenic	2.35	4.65				NA	
Barium	2.82	143	107	423	111	NA	122
Calcium	105	310,000	300,000	630,000	350,000	NA	500,000
Chromium	16.8	28.3	25.9	47.8	21.4	NA	32.8
Iron	77.5	1,370	279	418		NA	359
Lead	4.47			6.03	6.71	NA	
Magnesium	135	880,000	930,000	1,100,000	1,300,000	NA	1,800,000
Manganese	9.67	4,040	2,930	6,620	3,150	NA	4,860
Mercury	0.10					NA	
Potassium	1240	220,000	230,000	229,000	280,000	NA	390,000
Sodium	279	31,700	5,100,000	6,300,000	8,800,000	NA	12,000,000
Vanadium	27.6					NA	43.9
Cyanide	5.0						

LEGEND

CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
(shaded)	: Not Detected	VOCs:	volatile organic compounds
NA	: Not Analyzed	SVOCs:	semi-volatile organic compounds
		TICs:	tentatively identified compounds

§: antimony, beryllium, cadmium, cobalt, copper, nickel, selenium, silver, thallium and zinc not detected in any samples; metals were not analyzed in sample EL-MW-104 (dup)

4_22&23.wk1 07/27/93

Table 4.24
Aircraft Maintenance Area
Analytes Detected in Subsurface Soil from Test Pits

Analytes	Sample Loc.:	AM-TP-1			AM-TP-2			AM-TP-3			AM-TP-4			AM-TP-5			AM-TP-6		
	Depths (ft):	1	2	2.5	0.5	2.5	2.5(dup)	0.5	2.5	4.5	0.5	3	4.5	1.5	4	5.5	0.5	2	4
Analytes	CRL (mg/kg)	concentrations in mg/kg																	
VOCs																			
Toluene	0.100			0.19		0.15	0.21												
TICs		0.7	6,700	167										2.5	10.1				
SVOCs																			
TICs			28	19		1.1	0.9			23.3									
TPH	10(nc)	68.6	4,650	125	50.4														
Metals §																			
Aluminum	11.2	18,200	18,200	21,600	15,000	18,400	15,300	14,600	15,700	27,500	13,200	18,600	15,600	17,600	32,900	30,100	17,100	30,600	34,300
Arsenic	2.5							5.17						5.65	6.19			5.02	8.34
Barium	3.29	196	166	147	387	153	178	194	171	46.1	189	273	199	256	49.6	49.6	275	45.5	49.6
Beryllium	0.427	1.2	1.09	0.87	1.59	1.22	1.28	1.21	1.26	0.75	1.17	1.14	1.21	0.87	0.65		1.2	0.75	
Calcium	25.3	15,500	5,440	3,940	4,410	4,880	4,650	5,000	6,210	3,370	5,520	7,830	6,120	3,630	1,750	3,790	5,050	2,100	3,530
Chromium	1.04	28.4	18	45.5	12.4	29.3	14.3	17.4	12.9	81.3	23.6	30.3	21.6	39.5	86.7	87.8	87.5	80.8	99
Cobalt	2.5	12.2	9.35	9.38	7.42	9.64	6.61	10.9	9.83	10.3	9.15	12.8	10.3	11.1	10.2	15.1	13.2	10.8	19.2
Copper	2.84	23.4	10.4	21.8	8.54	13	7.96	9.36	7.67	39.6	8.2	36.7	15.4	32.5	40.1	31.3	28.3	35	36.8
Iron	6.66	25,200	18,600	28,700	20,800	23,100	19,200	21,200	19,000	40,300	19,700	28,000	21,700	24,200	41,200	48,300	24,800	42,000	60,300
Lead	0.467	7.53	9.39	8.28	7.6	8.57	7.87	8.27	8.69	4.11	8.28	8.94	9.12	10.9	7.83	8.93	15.7	7.32	10.3
Magnesium	10.1	6,340	4,080	6,270	3,460	4,880	3,660	4,120	3,640	9,210	3,900	5,850	4,730	6,400	7,520	12,200	7,090	8,630	12,900
Manganese	9.87	339	227	282	192	223	203	331	266	315	277	738	284	483	227	393	571	243	942
Nickel	2.74	36.9	20.1	36.7	17	28.9	17.7	20.7	16.5	56.1	20.8	40.2	30	53.9	53.5	73.9	61.3	54.1	72.9
Potassium	131	2,170	2,660	2,770	3,170	2,710	2,520	2,030	2,140	3,180	2,160	2,670	2,330	2,820	2,800	3,500	3,060	3,040	3,640
Sodium	38.7	206	162	301	175	213	148	307	344	870	267	265	352	189	419	959	113	295	630
Vanadium	1.41	37.8	31.2	44	22.1	35.4	32.2	28	25.1	67.3	26.7	44.6	31.1	33.9	86.8	70.6	35	64.6	78
Zinc	2.34	41.9	38.8	49.9	38.9	42.5	33.5	39.1	37	63.6	37	39.6	40.7	35.8	63.1	90.9	41	65.9	92.7
Cyanide	0.25																	0.53	0.79

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration
(nc): non-certified reporting limit
[shaded]: not detected
NA: not analyzed
§: antimony, cadmium, selenium, silver, and thallium not detected in any samples; and mercury not analyzed.

(dup): duplicate sample
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds

Table 4.25
Aircraft Maintenance Area
Analytes Detected in Groundwater and Soil from Well AM−MW−101
Phase I Investigation

		Water	
concentrations in $\mu g/L$			
Analytes	CRL	Values	(dup)
Metals §			
Arsenic	2.35	3.85	2.75
Barium	2.82	36.8	42.3
Calcium	105	47,600	52,700
Chromium	16.8	52.4	47
Iron	77.5	35,800	31,500
Magnesium	135	87,500	99,600
Manganese	9.67	3,630	3,650
Potassium	1,240	56,900	62,100
Sodium	279	740,000	860,000
Cyanide	5.0		
VOCs			
1,2−Dichloroethenes	5.00	5.3	5.4
Benzene	1.00		1.16
SVOCs			
TPH	100(nc)	NA	NA

		Soil	
	Depths (ft):	2.0	5.0
Analytes	CRL	concentrations in mg/kg	
Metals §			
Aluminum	11.2	19,000	
Barium	3.29	126	
Beryllium	0.427	1.22	
Calcium	25.3	9,680	
Chromium	1.04	13.7	
Cobalt	2.5	9.23	
Copper	2.84	10.8	
Iron	6.66	20,200	
Lead	0.467	8.18	NA
Magnesium	10.1	3,940	
Manganese	9.87	303	
Nickel	2.74	17.7	
Potassium	131	2,710	
Sodium	38.7	339	
Vanadium	1.41	33.4	
Zinc	2.34	40.9	
Cyanide	0.25		
VOCs			
Methylene chloride	4.40		6.72
Chloroform	0.240		1.91
SVOCs			
TPH	10(nc)		12.5

LEGEND

CRL:	USATHAMA Certified Reporting Limit Concentration	(dup):	duplicate sample
(nc):	Non−certified Reporting Limit	VOCs:	volatile organic compounds
[shaded] :	not detected	SVOCs:	semi−volatile organic compounds
NA :	not analyzed	TPH:	total petroleum hydrocarbons
		TICs:	tentatively identified compounds

§: aluminum, antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc not detected in water sample; antimony, arsenic, cadmium, selenium, silver, and thallium not detected and mercury not analyzed in soil sample, and metals not analyzed in soil sample at 5−foot depth.

4_25.wk1 07/27/93

Table 4.26
Aircraft Maintenance Area – Storage Areas 2 and 3
Analytes Detected in Subsurface Soil
Phase II Investigation

	Sample Loc:	AM-SB-1		AM-SB-2		AM-SB-3		AM-SB-4		AM-SB-5		AM-SB-6			AM-MW-102	AM-MW-103
	Depth (ft):	2	4	2	4	2	4	2	4	2	4	2	2*	4	2	3
Analytes	CRL (mg/kg)	concentrations in mg/kg														
VOCs	—	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	
SVOCs																
TICs	—	NA	NA	NA	NA	NA	0.6	NA	NA	NA	NA	NA	NA	NA	NA	1.0
TPH	10 (nc)		NA	143	NA	17.7			NA		NA			NA	NA	
Metals §																
Aluminum	11.2	22,400	11,300	14,500	21,300	15,700	12,800	17,500	19,000	47,400	58,300	22,800	24,100	28,200	28,400	20,500
Arsenic	2.5						4.44			3.32	13.2			3.63		
Barium	3.29	219	63.9	369	166	168	146	238	120	379	143	391	240	103	230	130
Beryllium	0.427	1.52	1.1	1.28	1.02	1.28	0.856	1.35	1.22	3.02	1.32	1.61	1.35	1.82	1.17	1.02
Boron	6.64	13.4	9.63	23.6	14.5	10.8	11.0	13.3	13.9	18	52.6	23.2	14.6	21.6	21.2	17.3
Calcium	25.3	5,170	7,740	17,000	2,310	5,580	3,190	6,510	7,350	18,200	6,550	6,500	6,760	17,100	11,700	8,060
Chromium	1.04	20.5	12.9	16.4	17.7	20.7	28.3	14.4	18.8	37.7	135	24.4	20.2	22.5	74.5	22.5
Cobalt	2.5	7.35	8.86	8.07	4.83	8.48	6.67	7.99	9.05	14.7	25.8	9.86	8.1	11.2	12.3	7.5
Copper	2.84	10.3	10.0	10.1	8.14	12.1	44.0	9.02	11.0	15.5	38.5	6.1	5.34	9.35	14.6	6.59
Iron	6.66	23,400	18,500	19,400	22,500	23,500	24,400	19,700	22,600	47,200	66,300	23,500	21,900	27,300	28,700	19,900
Lead	0.467	12.2	7.57	20.0	8.75	10.9	13.0	9.33	13.8	11.0	20.0	9.3	9.8	15	63	11
Magnesium	10.1	4,600	4,230	4,260	2,880	4,320	3,980	3,730	4,140	9,160	15,100	3,810	4,360	6,180	15,200	3,940
Manganese	9.87	236	268	372	183	235	309	246	264	603	489	362	251	387	430	293
Mercury	0.05	0.0773		0.0644		0.0745			0.074		0.103		0.101	0.0889	0.0862	
Nickel	2.74	20.7	16.9	16.8	14.4	22.9	27.5	18.6	17.7	36.4	111	19.1	18.2	26.1	98	16.6
Potassium	131	2,140	1,660	2,400	2,160	2,160	2,220	2,420	2,490	7,710	7,590	4,320	3,970	5,060	4,730	5,040
Sodium	33.7	522	278	170	323	229	198	314	327	950	2210	336	364	403	347	207
Vanadium	1.41	32.7	19.5	25.9	26.8	31.4	31.9	25.8	27.1	57.3	114	27.5	29.4	34.5	41.1	22.9
Zinc	2.34	42	42.2	42.5	29.9	40.9	37.5	37.9	41.7	89.8	111	40.9	37.2	54	68.4	38.2

LEGEND

CRL : USATHAMA certified reporting limit
(nc) : non-certified reporting limit
* : duplicate of previous sample
[shaded] : not detected
NA : not analyzed

VOCs : volatile organic compounds
SVOCs : semi-volatile organic compounds
TPH : total petroleum hydrocarbons
TICs : tentatively identified compounds
§ : antimony, cadmium, molybdenum, selenium, silver, tellurium, thallium and tin were not detected

4_26
12/08/92

Table 4.27
Aircraft Maintenance Area – Storage Area 4
Analytes Detected in Subsurface Soil
Phase II Investigation

	Sample Loc:	AM-SB-7		AM-SB-8		AM-SB-9		AM-SB-10		AM-MW-104
	Depth (ft):	2	4	2	4	2	4	2	4	2.5
Analytes	CRL (mg/kg)	concentrations in mg/kg								
VOCs	—	NA	NA	NA	NA	NA	NA	NA	NA	
SVOCs										
TICs	—	NA	NA	NA	NA	NA	NA	NA	NA	2.5
TPH	10 (nc)		NA	33.5	NA		NA	1060	NA	
Metals §										
Aluminum	11.2	30,000	59,300	21,000	59,300	24,200	51,200	13,800	55,300	87,000
Arsenic	2.5		4.15	8.57	9.46		4.49	7.02	5.07	9.2
Barium	3.29	186	96.7	814	152	231	74.1	69.1	70.6	171
Beryllium	0.427	1.61	0.932	0.832	1.11	1.57		1.32	1.15	1.18
Boron	6.64	20.3	33.5	10.0	25.1	13.4	27.7	9.08	30.1	42.2
Calcium	25.3	11,500	3,620	3,900	9,050	8,980	7,250	1,010	4,610	4,680
Chromium	1.04	20.4	142	20.3	108	18.8	127	29.3	129	150
Cobalt	2.5	6.89	14.9	6.49	18.5	6.74	13.9	4.99	18.0	22
Copper	2.84	10.3	39.7	10.0	43.7	5.78	40.7	14.0	44.4	51.8
Iron	6.66	22,400	74,700	20,200	49,900	18,700	53,800	10,900	67,600	59[illegible]
Lead	0.467	11	15	18	19	11	14	30	17	[illegible]
Magnesium	10.1	4,310	12,500	3,960	9,910	4,070	11,200	2,490	14,300	12,200
Manganese	9.87	203	346	359	686	283	368	320	413	580
Mercury	0.05		0.148		0.309		0.153	0.186		0.335
Nickel	2.74	19.5	85.4	23.1	78.7	17.0	76.6	23.5	100	96.4
Potassium	131	4,990	5,440	2,350	4,420	3,750	4,490	1,670	4,600	6,610
Sodium	38.7	212	433	276	1180	279	664	74	660	815
Vanadium	1.41	30.1	111	24.1	103	27.9	93.9	22.8	90.2	132
Zinc	2.34	40.4	88.1	28.5	84.0	38.6	85.7	24.3	109	94.4

LEGEND

CRL : USATHAMA certified reporting limit
(nc) : non-certified reporting limit
[shaded] : not detected
* : duplicate of previous sample
NA : not analyzed

VOCs : volatile organic compounds
SVOCs : semi-volatile organic compounds
TPH : total petroleum hydrocarbons
TICs : tentatively identified compounds
§ : antimony, cadmium, molybdenum, selenium, silver, tellurium, thallium, and tin were not detected

Table 4.28a
Aircraft Maintenance Area
Organic Analytes Detected in Storm Drain Sediment Samples
Phase I Investigation

	Sample Loc.:	AM-SD-1	AM-SD-2	AM-SD-3	AM-SD-3(dup)
	Depth (ft):	2.0(a)	2.0(a)	0.0	0.0
Analytes	CRL (mg/kg)	concentrations in mg/kg			
VOCs					
1,3-Dimethyl-benzene	0.230	1.03	0.34		
Benzene	0.100	0.39			
Methylene chloride	4.400	3.01			
Chlorobenzene	0.100	7.02			
Ethylbenzene	0.190	0.26			
Toluene	0.100	1.67	0.82		
Xylene	0.780	0.82			
1,1,2,2-Tetrachloro-ethane	0.200			0.23	
TICs		28	106		
SVOCs					
2-Methyl-naphthalene	0.032	1.83	2.13		
Acenaphthene	0.041	7.16	2.03		
Acenaphthylene	0.033	0.33			
Anthracene	0.710	2.8			
Bis(2-ethylhexyl)-phthalate	0.480	5.84	14.9		
Benzo[A]-anthracene	0.041	3.96	1.18	1.03	
Benzo[A]pyrene	1.20	6.55			
Benzo[B]-fluoranthene	0.310	4.56			
Benzo[G,H,I]-perylene	0.180	5.35			
Benzo[K]-fluoranthene	0.130	4.9	2.26		
Chrysene	0.032	6.65	1.53	1.53	
Dibenzofuran	0.038	2.79			
Fluoranthene	0.032	7.96	4.17	3.79	2.63
Fluorene	0.065	5.71	1.49		
Naphthalene	0.740		10.4		
Phenanthrene	0.032	15.1	5.68	4.77	3.03
Phenol	0.052	0.4	7.27		
Pyrene	0.083	6.2	4.39	3.26	2.16
TICs		34	185	3.5	4
TPH	10(nc)	1,940	2,390	1,230	1,220

LEGEND

(a):	depth to sediment below concrete surface adjacent to drain (except SD-3)		
CRL:	USATHAMA Certified Reporting Limit concentration	(dup):	duplicate sample
		VOCs:	volatile organic compounds
(nc):	non-certified reporting limit	SVOCs:	semi-volatile organic compounds
[shaded]:	not detected	TPH:	total petroleum hydrocarbons
NA:	not analyzed	TICs:	tentatively identified compounds

Table 4.28b
Aircraft Maintenance Area
Inorganic Analytes Detected in Storm Drain Sediment Samples
Phase I Investigation

	Sample Loc.:	AM-SD-1	AM-SD-2	AM-SD-3	AM-SD-3(dup)
	Depth (ft):	2.0(a)	2.0(a)	0.0	0.0
Analytes	CRL (mg/kg)	concentrations in mg/kg			
Metals §					
Aluminum	11.2	14,300	15,900	63,000	81,800
Barium	3.29	248	963	83.3	149
Beryllium	0.427			6.44	8.47
Boron	6.64	18.5	68.3	161	230
Cadmium	1.20	29.1	68.4		
Calcium	25.3	13,200	15,500	8,970	10,600
Chromium	1.04	129	711	40.6	96
Cobalt	2.50	13.4	14.5		
Copper	2.84	112	274	51.3	85.7
Iron	6.66	26,600	36,500	153,000	176,000
Lead	7.44	618	1,020		168
Magnesium	10.1	7,960	8,510	7,230	9,200
Manganese	9.87	308	359	568	754
Mercury	0.05	0.32	0.09		
Nickel	2.74	56.8	61.3	118	180
Potassium	131	1,790	1,540	2,460	4,140
Tin	7.43	14.4	14		
Silver	0.803		4.2		
Sodium	38.7	321	339	27,700	25,900
Vanadium	1.41	48.4	44.4	26.8	38.9
Zinc	2.34	616	588	175	290
Cyanide	0.25		0.63		

LEGEND			
(a):	depth to sediment below concrete surface adjacent to drain (except SD-3)		
CRL:	USATHAMA Certified Reporting Limit concentration		
[shaded box] :	not detected	(dup):	duplicate sample
§:	antimony, arsenic, molybdenum, tellurium, thallium, and selenium not detected in any samples; thallium not analyzed in sample AM-SD-2.		

4_28-b.wk1

07/27/93

Table 4.29a
Aircraft Maintenance Area
Organic Analytes Detected in Storm Drain Sediments
Phase II Investigation

	Sample Loc:	AM-SD-4	AM-SD-5		AM-SD-6	AM-SD-7	AM-SD-8
	Depth (a) (ft):	3.5	5.3	5.3*	8	6.4	3.5
Analytes	CRL (mg/kg)	concentrations in mg/kg					
VOCs							
1,2-Dichloroethenes	0.32					4.25	
SVOCs							
2-Methylnaphthalene	0.032	8.96		0.204	0.18		0.488
4-Methylphenol	0.24	1.48					
Acenaphthene	0.041	24.0	0.25	1.41	0.29	2.54	3.22
Acenaphthylene	0.033	1.27		0.0701			0.559
Anthracene	0.71	12.8				2.06	2.99
Benzo[A]anthracene	0.041	38.2		1.44	0.535	6.15	12.0
Benzo[A]pyrene	1.2	12.4				3.38	6.2
Benzo[B]fluoranthene	0.31	22.0		1.25		3.72	22.3
Benzo[G,H,I]perylene	0.18	22.0					12.5
Benzo[K]fluoranthene	0.13	20.3		1.03		2.65	10.4
Bis(2-ethylhexyl)phthalate	0.48					4.26	
Chrysene	0.032	40.7		1.55	0.939	4.88	12.0
Dibenzofuran	0.038	12.4				0.728	1.25
Dibenz[A,H]anthracene	0.31	3.63					2.52
Fluoranthene	0.032	12.4	0.354	2.09	0.691	4.75	6.20
Fluorene	0.065	41.1		0.732		2.0	2.55
Indeno[1,2,3-C,D]pyrene	2.4	13.6					10.5
Naphthalene	0.74	6.2					
Phenanthrene	0.032	24	0.698	4.44	1.55	9.39	23.9
Pyrene	0.083	12.4	0.719	3.59	1.68	9.01	6.2
TICs	--	95.0	14.0	2.9	16.4	17.81	32.0
TPH	10 (nc)	1,590	716	884	373	2,500	230

LEGEND

CRL : USATHAMA certified reporting limit
(nc) : non-certified reporting limit
* : duplicate of previous sample
[shaded cell] : not detected

VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds
(a): depth below concrete surface to top of sediment

4_26
05/26/93

Table 4.29b
Aircraft Maintenance Area
Inorganic Analytes Detected in Storm Drain Sediments
Phase II Investigation

	Sample Loc:	AM-SD-4	AM-SD-5		AM-SD-6	AM-SD-7	AM-SD-8
	Depth (a) (ft):	3.5	5.3	5.3*	8	6.4	3.5
Analytes	CRL (mg/kg)	concentrations in mg/kg					
Metals §							
Aluminum	11.2	25,400	31,300	7,220	31,400	23,200	15,400
Arsenic	2.5	3.89	6.0	23.5	6.48		3.0
Barium	3.29	502	1140	183	189	998	722
Beryllium	0.427	0.825	1.49		1.02		0.644
Boron	6.64	47.1	80.1	47.3	44.2	66.8	45.4
Cadmium	1.2	3.52	2.58		3.62		6.85
Calcium	25.3	14,200	13,500	7,520	22,600	11,600	15,300
Chromium	1.04	131	69.3	64.7	144	71.7	215
Cobalt	2.5	12.8	13.1		17.4	9.65	13.5
Copper	2.84	33.1	35.7	60.9	31.3	19.5	46.6
Iron	6.66	33,000	53,700	79,900	54,000	23,800	39,700
Lead	0.467	480	390	430	190	200	690
Magnesium	10.1	11,400	9,600	3,130	18,100	3,370	8,650
Manganese	9.87	423	507	605	602	242	381
Mercury	0.05	0.338			0.651		0.151
Nickel	2.74	61.6	71.2	28.4	71.5	42.8	60.5
Potassium	131	5,630	7,240	2,150	5,850	1,470	1,120
Sodium	38.7	837	555	1,250	1,460	3,440	265
Vanadium	1.41	50.4	86.9	26.7	75.1	33.7	51.3
Zinc	2.34	199	290	323	290	220	268

LEGEND

CRL : USATHAMA certified reporting limit
(nc) : non-certified reporting limit
* : duplicate of previous sample
[shaded] : not detected
(a) : depth below concrete surface to top of sediment

VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds
§ : antimony, molybdenum, selenium silver, tellurium, thallium and tin were not detected

Table 4.30
Aircraft Maintenance Area
Detected Analytes in Groundwater Samples
Phase II Investigation, Round 1

		Round 1				
	Sample Loc.:	101	102	103	103*	104
Analytes	CRL (µg/L)	concentrations in µg/L				
VOCs						
Chloromethane	1.2				8.53	
TICs	--		10			
SVOCs						
Napthalene	0.5			1.31	1.41	
TICs	--		36	20	40	
TPH	100 (nc)					
Metals §						
Aluminum	112		151			
Antimony	60					
Arsenic	2.35	8.33	15.7	21.1	20.5	12.0
Barium	2.82	45.3	10.7	53.9	59.7	163
Beryllium	1.12					
Calcium	105	65,100	16,500	107,000	116,000	94,000
Copper	18.8					
Iron	77.5	32,200	9,370	186,000	202,000	3,170
Lead	4.47					
Magnesium	135	161,000	21,700	187,000	204,000	211,000
Manganese	9.67	3,600	1,170	13,000	11,000	3,200
Nickel	32.1	39.2			40.5	35.7
Potassium	1240	81,600	22,900	73,400	79,500	101,000
Sodium	279	1,200,000	280,000	1,200,000	970,000	1,200,000
Zinc	18	58.8	37.3	90.9	48.7	75.7

LEGEND

CRL: USATHAMA certified reporting limit
(nc) : non-certified reporting limit
(shaded) : not detected

VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TPH: total petroleum hydrocarbons
TICs: tentatively identified compounds
§: cadmium, cobalt, chromium, mercury, selenium, silver, thallium, and vanadium were not detected; boron, molybdenum, tin and tellurium were not analyzed

Table 4.31
Aircraft Maintenance Area
Detected Analytes in Groundwater Samples
Phase II Investigation, Round 2

		Round 2			
	Sample Loc.:	101	102	103	104
Analytes	CRL ($\mu g/L$)	concentrations in $\mu g/L$			
VOCs					
Chloromethane	1.2				
TICs	--				
SVOCs					
Napthalene	0.5			1.98	
TICs	--			210	
TPH	100 (nc)				
Metals §					
Aluminum	112				
Antimony	60			86.3	
Arsenic	2.35	8.82	13.9	29.6	18.7
Barium	2.82	26.0	2.98	27.1	170
Beryllium	1.12	2.16	20.0	1.80	1.95
Boron	230	1,290	669	1,450	2,380
Calcium	105	43,900	9,720	97,700	91,600
Copper	18.8	20.9	21.4	60.9	
Iron	77.5	34,700	7,380	218,000	4,290
Lead	4.47		11.6	10.9	
Magnesium	135	96,200	13,700	170,000	258,000
Manganese	9.67	3,720	839	11,000	2,800
Nickel	32.1				
Potassium	1240	63,700	18,700	66,100	108,000
Sodium	279	760,000	200,000	940,000	2,100,000
Zinc	18	25.5	29.4	67.7	20.9

LEGEND

CRL: USATHAMA certified reporting limit
(nc): non-certified reporting limit
(shaded cell): not detected

VOCs : volatile organic compounds
SVOCs : semi-volatile organic compounds
TPH : total petroleum hydrocarbons
TICs : tentatively identified compounds
: cadmium, cobalt, chromium, molybdenum, mercury, selenium, silver, tin, tellurium, thallium and vanadium not detected

Table 4.32
Fuel Lines
Analytes Detected in Shallow Soil Samples

		TPH (mg/kg)	Lead (mg/kg)
	CRL (mg/kg):	10(nc)	0.467
JP-SS-1			86
JP-SS-2		82	16
JP-SS-3		111	16
JP-SS-4		40.9	14
JP-SS-5		50	33
JP-SS-5	(dup)	93.8	29
JP-SS-6		123	160
JP-SS-7		120	16
JP-SS-8		264	44
JP-SS-9		112	26
JP-SS-10		40	360
JP-SS-11		51.8	17
JP-SS-11	(dup)		48
JP-SS-13		46.3	14.3
JP-SS-13	(dup)	80.9	15.2
JP-SS-14			21.6
JP-SS-15			8.68
JP-SS-16			20.8
JP-SS-17			13.7
JP-SS-18			9.22

LEGEND

CRL: USATHAMA Certified Reporting Limit concentration

(nc): non-certified reporting limit

(shaded): not detected

(dup): duplicate sample

TPH: total petroleum hydrocarbons

APPENDIX B

BACKGROUND METALS DETECTED IN SOILS

Table B.1
Background
Analytes Detected in Inland Soil

	Sample Loc.:	BK-SS-1			BK-SS-6				BK-SS-7			Min	Max	Avg	St. Dev.
	Depths (ft):	0	2	5	0	2	5	5*	0.6	2	5				
Metals §	CRL (mg/kg)	concentrations in mg/kg													
Aluminum	11.2	29,000	49,400	42,900	61,200	43,200	48,800	36,900	39,200	42,600	31,800	29,000	61,200	42,500	8,813
Arsenic	2.5	2.85	5.38	5.16	9.97	1.250	7.33	8.21	6.53	6.1	7.16	1.25	9.97	5.99	2.40
Barium	3.29	133	98.8	80.0	91.4	63.3	76.5	51.7	77.2	66.6	44.8	44.80	133.00	78.33	24.05
Beryllium	0.427	0.96	0.77	0.214	0.824	0.648	0.214	0.214	0.566	0.214	0.214	0.214	0.960	0.484	0.287
Boron	6.64	3.320	3.320	3.320	22.4	22.3	32.4	27.3	30.0	30.3	23.7	3.32	32.40	19.84	11.28
Calcium	25.3	4,440	3,570	3,790	3,930	4,060	4,690	4,160	4,590	2,700	3,660	2,700	4,690	3,959	554
Chromium	1.04	44.1	121	97.4	131	114	125	110	107	125	101	44.10	131.00	107.55	23.58
Cobalt	2.50	11.5	12.0	13.2	15.6	17.9	18.4	15.1	19.5	13.5	14.7	11.50	19.50	15.14	2.59
Copper	2.84	22.7	42.2	30.4	55.3	40.7	42.8	35.6	34.7	38.3	32.7	22.70	55.30	37.54	8.26
Iron	6.66	25,100	62,300	49,900	52,900	53,500	58,900	54,000	52,100	62,000	53,500	25,100	62,300	52,420	9,946
Lead	0.467	34	14.4	9.82	32.0	6.7	12.2	15.0	21.1	14.9	10.1	6.70	34.00	17.02	8.80
Magnesium	10.1	6,520	12,000	12,700	10,500	13,200	15,000	14,100	14,300	12,000	13,400	6,520	15,000	12,372	2,313
Manganese	9.87	340	265	353	372	578	489	370	964	310	444	265	964	449	192
Mercury	0.05	NA	NA	NA	0.309	0.131	0.101	0.0795	0.0638	0.025	0.025	0.00	0.31	0.07	0.09
Nickel	2.74	55.5	66.1	71.1	85.6	92	102	89.4	95.6	70.5	80.1	55.50	102.00	80.79	13.96
Potassium	131	5,160	7,390	5,260	4,410	3,820	4,500	3,950	5,320	4,790	3,690	3,690	7,390	4,829	1,023
Selenium	0.449	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.22	0.22	0.22	–
Sodium	38.7	315	1,510	1,670	275	425	1,580	1,670	389	559	1,180	275	1,670	957	583
Vanadium	1.41	48.2	113	82.6	112	79.7	92.7	84.1	76.5	85.4	69.5	48.20	113.00	84.37	18.08
Zinc	2.34	66.8	83.5	82.7	93.6	92	101	95.2	102	98.5	88.8	66.80	102.00	90.41	10.07

LEGEND

CRL : USATHAMA certified reporting limit
(shaded) : not detected (½ CRL value inserted)
NA : not analyzed
* : duplicate

§ : antimony, cadmium, molybdenum, silver, tellurium, thallium, and tin not detected in BK-SS-6 and BK-SS-7 samples;
: antimony, cadmium, silver, and thallium not detected in BK-SS-1 samples. Cyanide not analyzed in all samples.

4_1.wk1
04/12/94

Table B.2
Background
Analytes Detected in Wetland Soil

	Sample Loc.:	BK-SS-3		BK-SS-4			BK-SS-5		BK-SS-8	BK-SS-9	BK-SS-10	Min	Max	Avg	St. Dev.
	Depths (ft):	0.5	2	0	2	2*	0.5	1.5	1.5	1.5	1.5				
Metals §	CRL (mg/kg)	concentrations in mg/kg													
Aluminum	11.2	40,400	59,800	66,500	73,900	55,300	54,100	62,000	85,600	83,100	74,400	40,400	85,600	65,510	13,316
Arsenic	2.5	9.22	7.77	5.86	9.02	7.8	11.0	14.5	10.9	11.0	10.0	5.86	14.50	9.71	2.25
Barium	3.29	55.6	98.4	148	188	146	90	118	259	182	172	55.6	259.0	145.7	55.56
Beryllium	0.427	0.2135	0.2135	1.41	1.68	0.849	0.2135	0.2135	1.42	1.45	1.19	0.2135	1.680	0.89	0.58
Boron	6.64	34.4	52.3	50.7	71.6	43.1	42.9	50.9	77.8	85.4	69.6	34.4	85.40	57.87	16.14
Calcium	25.3	3,960	4,660	5,130	4,610	3,890	4,540	5,000	5,540	6,220	5,430	3,890	6,220	4,898	683
Chromium	1.04	114	147	133	139	118	138	149	168	177	157	114	177	144.0	19.04
Cobalt	2.5	17.2	20.4	24.1	20.7	16.8	26.7	21.0	16.4	25.0	22.3	16.4	26.7	21.1	3.37
Copper	2.84	66.7	75	66.9	68.1	56.3	71.4	73.6	80.7	89.1	80.8	56.3	89.1	72.9	8.75
Iron	6.66	53,900	57,000	62,700	54,500	46,100	61,200	64,900	61,900	71,100	64,800	46,100	71,100	59,810	6,722
Lead	0.467	28.1	36.5	31.0	39.0	31.0	30.7	40.4	46.0	57.0	38.0	28.1	57	37.8	8.26
Magnesium	10.1	16,100	17,400	17,800	17,700	14,600	18,300	18,100	19,900	21,200	19,300	14,600	21,200	18,040	1,769
Manganese	9.87	627	370	1150	345	286	1260	391	359	450	437	286	1260	567.5	331.00
Mercury	0.05	0.348	0.384	0.343	0.538	0.35	0.388	0.502	0.527	0.642	0.443	0.343	0.642	0.45	0.10
Nickel	2.74	104	118	114	116	97	132	122	116	137	125	97	137	118.1	11.33
Potassium	131	4,660	6,690	8,440	10,200	8,390	5,590	6,730	12,500	10,600	9,610	4,660	12,500	8,341	2,322
Selenium	0.449	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	0.2245	1.5	0.2245	0.2245	1.5	0.35	0.38
Sodium	38.7	15,600	16,400	17,300	17,600	11,700	15,600	16,600	14,900	18,700	16,700	11,700	18,700	16,110	1,801
Vanadium	1.41	81.2	112	123	136	96.7	102	119	151	154	135	81.2	154	121.0	22.44
Zinc	2.34	139	149	134	169	123	156	163	167	186	160	123	186	154.6	17.74

LEGEND

CRL : USATHAMA certified reporting limit
* : duplicate

[shaded] : not detected (½ CRL value inserted)
NA : not analyzed

§ : antimony, cadmium, molybdenum, silver, tellurium, thallium, and tin not detected in BK-SS-3, -4, -5, -8, -9, and -10 samples;
: Sample location BK-SS-2 was removed from this dataset because it may have been influenced by metals contamination at the North Pump Station discharge area.
: Cyanide not analyzed in all samples.

4_1.wk1
04/12/94

APPENDIX C

SOIL SCREENING COMPARISON
WATER SCREENING COMPARISON

APPENDIX C

SUMMARY OF SCREENING TABLES

TABLE NUMBERING FORMAT

Example: C.1.2.a

First Designation - Appendix Number
Second Designation - Site Number
Third Designation - Media of Concern
Fourth Designation - Subarea of Concern

Legend:

1) Second Designation - Site Number

   1 = Site 1: POL Area
   2 = Site 2: Burn Pit
   3 = Site 3: Revetment Area
   4 = Site 4: Pump Station
   5 = Site 5: Former Sewage Treatment Plant
   6 = Site 6: East Levee Landfill
   7 = Site 7: Aircraft Maintenance and Storage
   8 = Site 8: Fuel Lines
   9 = Site 9: Building 442 AST

2) Third Designation - Media of Concern

   1 = Soil
   2 = Deep Soil
   3 = Sediment
   4 = Groundwater
   5 = Surface Water

3) Fourth Designation - Subarea of Concern

SOIL SCREENING COMPARISON

Table C.1.1

Preliminary Remediation Goals (PRGs)
POL Area (Shallow Soil)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Bis(2-ethylhexyl)phthalate	1.52E+00	4.57E+01	5.40E+03			NO	NO		
Lead	7.72E+00								
TPH	1.59E+01								

* 1,3-Dimethylbenzene is a xylene isomer.

** California Applied Action Levels for Soil

05/04/94

C_1_1.WK1

Table C.1.2

Preliminary Remediation Goals (PRGs)
POL Area (Deep Soil)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goal			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Bis(2-ethylhexyl)phthalate	3.02E+00	4.57E+01	5.40E+03			NO	NO		
Lead	1.60E+01								
Methylnaphthalene (2-)	3.00E-01								
TPH	5.03E+02								

05/04/94

C_1_2.WK1

Table C.2.1

Preliminary Remediation Goals (PRGs)
Burn Pit (Soil Depth: 0-2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil: Risk-based Carc.	PRGs for Soil: Risk-based Non-Carc.	PRGs for Soil: ARAR-based	Other Clean-up Goals	Exceed PRG or Clean-up Goals: Carc.	Exceed PRG or Clean-up Goals: Non-carc.	Exceed PRG or Clean-up Goals: ARAR-based	Exceed PRG or Clean-up Goals: Other Goals
Benzo(a)anthracene	2.40E-01								
Bis(2-ethylhexyl)phthalate	8.79E+00	4.57E+01	5.40E+03			NO	NO		
Chrysene	1.90E-01								
Ethylbenzene	7.00E-01		2.70E+04				NO		
Fluoranthene	3.90E-01		1.08E+04				NO		
Florene	5.10E-01		1.08E+04				NO		
Lead	5.50E+01								
2-Methylnaphthalene	1.12E+01								
Napthalene	8.59E+00		1.08E+04				NO		
Phenanthrene	7.10E-01			1.00E+02				NO	
Pyrene	4.00E-01		8.10E+03				NO		
TPHs	1.92E+03								
Toluene	5.90E-01		5.40E+04				NO		
Xylenes	1.66E+00		5.40E+05	3.00E+04			NO	NO	

05/04/94

C_2_1.WK1

Table C.2.2

Preliminary Remediation Goals (PRGs)

Burn Pit (Soil Depth: >2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soils			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-Carc.						
Bis(2-ethylhexyl)phthalate	2.30E+00	4.57E+01	5.40E+03			NO	NO		
Fluoranthene	1.50E-01		1.08E+04				NO		
Lead	1.93E+01								
Methylene Chloride	5.16E+00	8.53E+01	1.62E+04			NO	NO		
2-Methylnaphthalene	6.35E+00								
Napthalene	3.03E+00								
Phenanthrene	9.40E-01		1.08E+04	1.00E+02			NO	NO	
TPHs	1.59E+03								
Toluene	5.20E-01		5.40E+04				NO		
Xylenes	8.10E-01		5.40E+05	3.00E+04			NO	NO	

05/04/94

C_2_2.WK1

Table C.3.1

Preliminary Remediation Goals (PRGs)
Revetment Area (Soil Depth: 0–2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean–up Goals	Exceed PRG or Clean–up Goals			
		Risk–based		ARAR–based		Carc.	Non–carc.	ARAR–based	Other Goals
		Carc.	Non–carc.						
Benzo(a)anthracene	1.46E+00								
Bis(2–ethylhexyl)phthalate	9.80E–01	4.57E+01	5.40E+03			NO	NO		
Chrysene	2.70E–01								
Fluoranthene	4.80E–01		1.08E+04				NO		
Lead	4.40E+01								
Phenanthrene	4.40E–01			1.00E+02				NO	
Pyrene	7.80E–01		8.10E+03				NO		
Toluene	2.10E–01		5.40E+04				NO		

05/04/94

C_3_1.WK1

Table C.3.2

Preliminary Remediation Goals (PRGs)
Revetment Area (Soil Depth: >2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Bis(2-ethylhexyl)phthalate	2.17E+00	4.57E+01	5.40E+03			NO	NO		
Lead	5.10E+01								
Toluene	2.80E-01		5.40E+04				NO		

05/04/94

C_3_2.WK1

Table C.4.1

Preliminary Remediation Goals (PRGs)
Pump Station (Soil Depth: 0–2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil Risk–based Carc.	PRGs for Soil Risk–based Non–carc.	PRGs for Soil ARAR–based	Other Clean–up Goals	Exceed PRG or Clean–up Goals Carc.	Exceed PRG or Clean–up Goals Non–carc.	Exceed PRG or Clean–up Goals ARAR–based	Exceed PRG or Clean–up Goals Other Goals
Acenaphthylene	5.63E+00								
Benzo(a)anthracene	1.96E+01								
Benzo(a)pyrene	6.20E+00	1.11E–01				YES			
Benzo(g,h,i)perylene	1.53E+01								
Benzo(k)fluoranthene	1.47E+01								
BHC (beta–)	4.61E+01	3.56E–01				YES			
Chrysene	1.15E+01								
Dibenz(a,h)anthracene	1.37E+01								
Fluoranthene	3.10E+01		1.08E+04				NO		
Fluorene	6.90E–01		1.08E+04				NO		
Indeno(1,2,3–cd)pyrene	1.10E+01								
Lead	4.10E+02								
Methylnaphthalene (2–)	1.07E+02								
Naphthalene	3.69E+01		1.08E+04				NO		
Phenanthrene	8.16E+01			1.00E+02				NO	
Pyrene	3.10E+01		8.10E+03				NO		
Toluene	7.50E–01		5.40E+04				NO		
TPH	3.32E+05								
Trichlorophenol (2,4,6–)	1.12E+01	5.82E+01				NO			

05/04/94
C_4_1.WK1

Table C.4.2

Preliminary Remediation Goals (PRGs)

Pump Station (Soil Depth: >2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Lead	1.20E+01								
Toluene	5.70E-01		5.40E+04				NO		

05/04/94

C_4_2.WK1

Table C.4.3

Preliminary Remediation Goals (PRGs)
Pump Station (Sediment)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Sediment			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	other Goals
		Carc.	Non-carc.						
Aluminum	7.01E+04								
Arsenic	1.61E+01	3.56E-01	8.10E+01			YES	NO		
Barium	1.65E+02		1.89E+04				NO		
Benzo(a)anthracene	4.90E-01								
Benzo(g,h,i)perylene	1.39E+00								
Benzo(k)fluoranthene	8.70E-01								
Beryllium	7.21E+00	1.49E-01	1.35E+03			YES	NO		
Bis(2-ethylhexyl)phthalate	2.80E+00	4.57E+01	5.40E+03			NO	NO		
Boron	9.94E+01		2.43E+04				NO		
Chromium	2.34E+02		1.35E+03				NO		
Chrysene	6.80E-01								
Cobalt	9.47E+01								
Copper	1.31E+02		1.08E+04				NO		
DDD (2,2-)	3.03E+00	2.67E+00				YES			
DDT(2,2-)	2.50E-01	1.88E+00	1.35E+02			NO	NO		
Fluoranthene	6.10E-01		1.08E+04				NO		
Lead	8.90E+02								
Manganese	4.70E+03		2.70E+04				NO		
Mercury	3.70E-01		8.10E+01				NO		
Nickel	3.10E+02		5.40E+03				NO		
Phenanthrene	7.90E-01			1.00E+02				NO	
Pyrene	9.50E-01		8.10E+03				NO		
Selenium	1.35E+00		1.35E+03				NO		
Silver	6.61E+00		1.35E+03				NO		
TPH	2.69E+03								

Table C.5.1

Preliminary Remediation Goals (PRGs)
Former Sewage Treatment Plant (Shallow Soil)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-Carc.						
Aldrin	3.27E-02		8.10E+00			YES	NO		
Aluminum	3.45E+04								
Arsenic	7.41E+00	3.56E-01	8.10E+01			YES	NO		
Barium	2.40E+02		1.89E+04				NO		
Benzo(a)anthracene	1.68E-01								
Beryllium	9.53E-01	1.49E-01	1.35E+03			YES	NO		
Bis(2-ethylhexyl)phthalate	2.07E+00	4.57E+01	5.40E+03			NO	NO		
Cadmium	4.60E+00		1.35E+02				NO		
Chromium	8.66E+01		1.35E+03				NO		
Cobalt	1.65E+01								
Copper	1.28E+02		1.08E+04				NO		
Cyanide	5.30E-01		5.40E+03				NO		
DDD(2,2-)	1.48E+00	2.67E+00				NO			
DDE(2,2-)	1.04E-01	1.88E+00				NO			
DDT(2,2-)	1.99E-01	1.88E+00	1.35E+02			NO	NO		
Dieldrin	3.33E-02	4.00E-02				NO			
Di-n-butylphthalate	1.46E+00		2.70E+04				NO		
Endrin	2.27E-02		8.10E+01				NO		
Endrin ketone	5.67E-03								
Fluoranthene	1.94E-01		1.08E+04				NO		
Heptachlor epoxide	2.92E-02	7.03E-02	3.51E+00			NO	NO		
Isodrin	1.04E-02	1.31E+02	8.10E+00			NO	NO		
Lead	8.23E+01								
Manganese	6.25E+02		2.70E+04				NO		
Mercury	2.50E+00		8.10E+01				NO		
2-Methylnaphthalene	1.09E-01								
Nickel	8.07E+01		5.40E+03				NO		
PCB 1254	1.20E+00	8.31E-02				YES			

Table C.5.1 (continued)

Preliminary Remediation Goals (PRGs)
Former Sewage Treatment Plant (Shallow Soil)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-Carc.						
Phenanthrene	2.21E-01			1.00E+02				NO	
Selenium	1.95E+00		1.35E+03				NO		
Silver	1.72E+01		1.35E+03				NO		
Tin	3.62E+01		1.62E+05				NO		
Toluene	2.67E-01		5.40E+04				NO		
TPHC	2.60E+03								
Vanadium	6.04E+01		1.89E+03				NO		
Zinc	3.82E+02		5.40E+04				NO		

05/04/94

C_5_1.WK1

Table C.5.3

Preliminary Remediation Goals (PRGs)
Former Sewage Treatment Plant (Sediment)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Sediment			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR based	Other Goals
		Carc.	Non-carc.						
Aluminum	4.66E+04								
Barium	1.37E+02		1.89E+04				NO		
Boron	5.19E+01		2.43E+04				NO		
Chromium	9.21E+01		1.35E+03				NO		
Cobalt	2.42E+01								
Copper	4.54E+01		1.08E+04				NO		
Cyanide	8.90E-01		5.40E+03				NO		
Fluoranthene	1.80E-01		1.08E+04				NO		
Lead	1.98E+01								
Manganese	3.30E+03		2.70E+04				NO		
Mercury	8.40E+00		8.10E+01				NO		
Nickel	8.78E+01		5.40E+03				NO		
Phenanthrene	1.20E-01			1.00E+02				NO	
Vanadium	9.64E+01		1.89E+03				NO		
Zinc	1.75E+02		5.40E+04				NO		

* 1,3-Dimethylbenzene is a xylene isomer.

** California Applied Action Levels for Soil

05/04/94

C_5_3.WK1

Table C.6.2

Preliminary Remediation Goals (PRGs)
East Levee Landfill (Soil Depth: >2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-Carc.	ARAR-based	Other Goals
		Carc.	Non-Carc.						
Aluminum	5.41E+04								
Arsenic	1.31E+01	3.56E-01	8.10E+01			YES	NO		
Barium	1.71E+02		1.89E+04				NO		
Beryllium	2.09E+00	1.49E-01	1.35E+03			YES	NO		
Bis(2-ethylhexyl)phthalate	3.09E+00	4.57E+01	5.40E+03			NO	NO		
Cadmium	4.96E+00		1.35E+02				NO		
Chromium	1.27E+02		1.35E+03				NO		
Cobalt	1.94E+01								
Copper	7.80E+01		1.08E+04				NO		
Lead	9.60E+01								
Manganese	5.05E+02		2.70E+04				NO		
Nickel	8.73E+01		5.40E+03				NO		
Nitrate	1.48E+01		4.32E+05				NO		
Silver	2.06E+00		1.35E+03				NO		
Vanadium	1.30E+02		1.89E+03				NO		
Zinc	3.27E+02		5.40E+04				NO		

05/04/94

C_6_2.WK1

Table C.7.1

Preliminary Remediation Goals (PRGs)
Aircraft Maintenance Area (Soil Depth: 0-2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Aluminum	4.74E+04								
Arsenic	8.57E+00	3.56E-01	8.10E+01			YES	NO		
Barium	8.14E+02		1.89E+04				NO		
Beryllium	3.02E+00	1.49E-01	1.35E+03			YES	NO		
Boron	2.36E+01		2.43E+04				NO		
Chromium	8.75E+01		1.35E+03				NO		
Cobalt	1.47E+01								
Copper	3.50E+01		1.08E+04				NO		
Cyanide	5.30E-01		5.40E+03				NO		
Lead	6.30E+01								
Manganese	6.03E+02		2.70E+04				NO		
Mercury	1.86E-01		8.10E+01				NO		
Nickel	9.80E+01		5.40E+03				NO		
TPH	4.65E+03								
Vanadium	6.46E+01		1.89E+03				NO		
Zinc	8.98E+01		5.40E+04				NO		

05/04/94

C_7_1.WK1

Table C.7.2

Preliminary Remediation Goals (PRGs)
Aircraft Maintenance Area (Soil Depth: >2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goals			
		Risk-based		ARAR-based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Aluminum	8.70E+04								
Arsenic	1.32E+01	3.56E-01	8.10E+01			YES	NO		
Barium	2.73E+02		1.89E+04				NO		
Beryllium	1.82E+00	1.49E-01	1.35E+03			YES	NO		
Boron	5.26E+01		2.43E+04				NO		
Chromium	1.50E+02		1.35E+03				NO		
Cobalt	2.58E+01								
Copper	5.18E+01		1.08E+04				NO		
Cyanide	7.90E-01		5.40E+03				NO		
Lead	2.30E+01								
Manganese	9.42E+02		2.70E+04				NO		
Mercury	3.35E-01		8.10E+01				NO		
Nickel	1.11E+02		5.40E+03				NO		
Toluene	2.10E-01		5.40E+04				NO		
TPH	1.25E+02								
Vanadium	1.32E+02		1.89E+03				NO		
Zinc	1.11E+02		5.40E+04				NO		

05/04/94

C_7_2.WK1

Table C.7.3

Preliminary Remediation Goals (PRGs)
Aircraft Maintenance Area (Sediment)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil: Risk-based Carc.	PRGs for Soil: Risk-based Non-carc.	PRGs for Soil: ARAR-Based	Other Clean-up Goals	Exceed PRG or Clean-up Goal: Carc.	Exceed PRG or Clean-up Goal: Non-carc.	Exceed PRG or Clean-up Goal: ARAR-based	Exceed PRG or Clean-up Goal: Other Goals
Acenaphthene	2.40E+01		1.62E+04				NO		
Acenaphthylene	1.27E+00								
Aluminum	8.18E+04								
Anthracene	1.28E+01		8.10E+04	1.00E+02			NO	NO	
Arsenic	2.35E+01	3.56E−01	8.10E+01			YES	NO		
Barium	1.14E+03		1.89E+04				NO		
Benzene	3.90E−01	2.21E+01				NO			
Benzo(a)anthracene	3.82E+01								
Benzo(a)pyrene	1.24E+01	1.11E−01				YES			
Benzo(b)fluoranthene	2.23E+01								
Benzo(g,h,i)perylene	2.20E+01								
Benzo(k)fluoranthene	2.03E+01								
Beryllium	8.47E+00	1.49E−01	1.35E+03			YES	NO		
Bis(2−ethylhexyl)phthalate	1.49E+01	4.57E+01	5.40E+03			NO	NO		
Boron	2.30E+02		2.43E+04				NO		
Cadmium	6.84E+01		1.35E+02				NO		
Chlorobenzene	7.02E+00								
Chromium	7.11E+02		1.35E+03				NO		
Chrysene	4.07E+01								
Cobalt	1.74E+01								
Copper	2.74E+02		1.08E+04				NO		
Cyanide	6.30E−01		5.40E+03				NO		
Dibenz(a,h)anthracene	3.63E+00								
Dibenzofuran	1.24E+01								
Dichloroethane (1,2−)	4.25E+00		2.70E+03				NO		
Dimethylbenzene (1,3−)*	1.03E+00		5.40E+05				NO		
Ethylbenzene	2.60E−01		2.70E+04				NO		
Fluoranthene	1.24E+01		1.08E+04				NO		

Table C.7.3 (continued)

Preliminary Remediation Goals (PRGs)
Aircraft Maintenance Area (Sediment)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean-up Goals	Exceed PRG or Clean-up Goal			
		Risk-based		ARAR-Based		Carc.	Non-carc.	ARAR-based	Other Goals
		Carc.	Non-carc.						
Fluorene	4.11E+01		1.08E+04				NO		
Indeno(1,2,3-cd)pyrene	1.36E+01								
Lead	1.02E+03								
Manganese	7.54E+02		2.70E+04				NO		
Mercury	6.51E-01		8.10E+01				NO		
Methylene chloride	3.01E+00	8.53E+01	1.62E+04			NO	NO		
Methylphenol (4-)	1.48E+00		1.35E+04				NO		
Methylnaphthalene (2-)	8.96E+00								
Naphthalene	1.04E+01		1.08E+04				NO		
Nickel	1.80E+02		5.40E+03				NO		
Phenanthrene	2.40E+01			1.00E+02				NO	
Phenol	7.27E+00		1.62E+05				NO		
Pyrene	1.24E+01		8.10E+03				NO		
Selenium	1.44E+01		1.35E+03				NO		
Silver	4.20E+00		1.35E+03				NO		
Tetrachloroethane (1,1,2,2-)	2.30E-01	3.20E+00				NO			
Toluene	1.67E+00		5.40E+04				NO		
TPH	2.50E+03								
Vanadium	8.69E+01		1.89E+03				NO		
Xylenes	8.20E-01		5.40E+05	3.00E+04			NO	NO	
Zinc	6.16E+02		5.40E+04				NO		

* 1,3-Dimethylbenzene is a xylene isomer.

05/04/94
C_7_3.WK1

Table C.9.1

Preliminary Remediation Goals (PRGs)
Building 442 (Soil Depth: 0–2 feet)

Chemical Name	Maximum Concentration (mg/kg)	PRGs for Soil			Other Clean–up Goals	Exceed PRG or Clean–up Goals			
		Risk–based PRG		ARAR–based		Carc.	Non–carc.	ARAR–based	Other Goals
		Carc.	Non–carc.						
Lead	2.70E+01								

05/04/94

C_9_1.WK1

WATER SCREENING COMPARISON

Table C.1.4

POL Area

Comparison of Maximum Groundwater Concentration with ARARs

Analytes	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	Exceed
VOC				
1,3 Dimethylbenzene	479	600		no
Benzene	9.69	5	1	yes
Toluene	10	1,000	100	no
Ethylbenzene	210	700	680	no
Xylene	371	10,000	1,750	no
SVOC				
Bis(2-ethylhexylphthlate)	29.3	6	4	yes
2-Methylnaphthalene	89			
Naphthalene	90.4			
TPH	14,000			
Lead	6.4	50	50	no

04/19/94

C_1_4.WK1

Table C.2.4
Burn Pit
Comparison of Maximum Groundwater Concentrations With ARARs

Analytes	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	exceed
VOC				
Methylethyl ketone	29.9			
SVOCs				
TPH	140			
Lead	9.13	50	50	no

04/19/94

C_2_4.WK1

Table C.3.4

Revetment Area

Comparison of Maximum Groundwater Concentrations with ARARs

Analyte	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	Exceed
VOC	ND			
SVOC	ND			
TPH	ND			
Metals				
Arsenic	7.28	50	50	no
Lead	8.8	50	50	no
Barium	70.5	200	100	no
Calcium	230,000			
Copper	30.9			
Iron	489			
Mercury		2	2	no
Potassium	201,000			
Magnesium	680,000			
Manganese	1,050		50	yes
Selenium		50 (1)	10	no
Sodium	4,500,000			
Cyanide	12.6	200		no

Notes:

(1) – Secondary MCL

04/19/94

C_3_4.WK1

Table C.4.4

Pump Station
Comparison of Maximum Groundwater Concentrations with ARARs

Analyte	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	Exceed
VOCs				
Methylethyl ketone	32.2			
SVOCs				
TPH				
Metals				
Barium	109	200	100	no
Calcium	320,000			
Chromium	32.5	100	50*	no
Potassium	233,000			
Magnesium	700,000			
Manganese	4,360		50 (1)	yes
Sodium	4,500,000			
Nickel	38.6	100		no
Zinc	35.8			
Cyanide	18.5	200		no
Cyanide*	10.4			

Notes:

* Assumes Cr VI, however, groundwater analysis at HAA is for total chromium.

(1) – Secondary MCL

04/19/94

C_4_4WK1

Table C.5.4
Former Sewage Treatment Plant
Comparison of Maximum Groundwater Concentrations with ARARs

Analyte	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	Exceed
VOCs				
1,3-Dimethylbenzene	2.83	600		no
Acetone	198			
Benzene	1.4	5	1	yes
Chlorobenzene	20.2	100	30	no
Toluene	1.7	1,000	100	no
Methylethyl ketone	75.9			
Methylisobutylketone	10.8			
Xylene	3.17	10,000	1,750	no
SVOCs				
1,4-Dichlorobenzene	15	75	5	yes
2-Methylnaphthalene	3.72			
4-Methylnaphthalene	21.6			
Naphthalene	5.23			
Phenol	232		5	yes
Metals				
Arsenic	15.6	50	50	no
Mercury	0.34	2	2	no
Aluminum	558		1,000	no
Barium	144	2,000	1,000	no
Beryllium	1.8	4		no
Calcium	1,100,000			
Iron	396			
Potassium	70,900			
Magnesium	3,050			
Manganese	ND		50 (1)	no
Sodium	4,600,000			
Nickel	57.6	100		no
Antimony	101	6		yes
Zinc	26.8			
Cyanide	ND	200		no
Anions				
Alkalinity bicarbonate	230,000			
Alkalinity carbonate	49,000			
Nitrate,-ite	32.6	1000		no
Chloride	8,000,000		250,000 (1)	yes
Sulfate	460,000			

Notes:

(1) - Secondary MCL

04/19/94

C_5_4.WK1

Table C.5.5

Former Sewage Treatment Plant
Comparison of Maximum Surface Water Concentrations with ARARs

Analyte	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	Exceed
VOCs	ND			no
SVOCs	ND			no
Metals				
Arsenic	6.31	50	50	no
Mercury	ND	2	2	no
Aluminum	ND		1,000	no
Barium	200	2,000	1,000	no
Beryllium	ND	4		no
Calcium	630,000			
Iron	2.7			
Potassium	220,000			
Magnesium	1,300,000			
Manganese	2,130		50 (1)	yes
Sodium	8,900,000			
Nickel	ND	100		no
Antimony	ND	6		no
Zinc	ND			
Cyanide	ND	200		no
Anions				
Nitrate,–ite	63	1,000		no
Chloride	13,000,000		250,000 (1)	yes
Fluoride	42,000	4,000		yes
Sulfate	1,900,000			

Notes:

(1) – Secondary MCL

04/19/94

C_5_5.WK1

Table C.6.4
East Levee Landfill
Comparison of Maximum Groundwater Concentrations with ARARs

Analyte	Maximum (ug/L)	EPA MCL (ug/L)	CA MCL (ug/L)	Exceed
VOCs				
Methylethyl ketone	27.6			
SVOCs	ND			
Anions				
Alkalinity bicarbonate	2,600,000			
Nitrate,–ite	66.5	1,000		no
Chloride	20,000,000		250,000 (1)	yes
Fluoride	6,400,000	4,000		yes
Sulfate	680,000			
Metals				
Arsenic	4.65	50	50	no
Lead	6.71	50	50	no
Aluminum	239		1,000	no
Barium	423	2,000	1,000	no
Calcium	630000			
Chromium	47.8	100	50*	no
Iron	1,370			
Potassium	390,000			
Magnesium	1,800,000			
Manganese	6,620		50 (1)	yes
Mercury			1,000	no
Sodium	12,000,000			
Vanadium	43.9			
Cyanide	ND	200		no

Notes:

* – Assumes CrVI, however groundwater analysis at HAA is for total Chromium.

(1) – Secondary MCL

04/19/94

C_6_4.WK1

Table C.7.4
Aircraft Maintenance Area
Comparison of Maximum Groundwater Concentrations with ARARs

Analyte	Maximum (µg/L)	EPA MCL (µg/L)	CA MCL (µg/L)	Exceed
VOCs				
1,2-Dichloroethene	5.4	7	6 (1)	no
Benzene	1.16	5	1	yes
Chloromethane	8.53			
SVOCs				
Naphthalene	1.98			
TPH	ND			
Metals				
Aluminum	151	50	1,000	no
Antimony	86.3	6	50	yes
Arsenic	29.6	50	50	no
Barium	170	2,000	1,000	no
Beryllium	20	4		yes
Boron	2,380			
Calcium	116,000			
Chromium	52.4	100	50 (2)	yes
Copper	60.9	1,300 (3)		no
Iron	218,000			
Lead	11.6	50	50	no
Magnesium	258,000			
Manganese	13,000		50 (4)	yes
Nickel	40.5	100		no
Potassium	108,000			
Sodium	2,100,000			
Zinc	90.9			
Cyanide	ND	200		no

Notes:

(1) – Assumes cis– and trans–DCE

(2) – Assumes Cr VI, however, groundwater analysis at HAA is for total Chromium.

(3) – Proposed MCL

(4) – Secondary MCL

04/19/94

C_7_4.WK1

APPENDIX D

COST ESTIMATES

APPENDIX D

COST ESTIMATE TABLES

Soil Cost Estimate Tables for Development Option

Table	Remedial Alternative
Site 1: POL Area	
D-1.1	S1
D-1.2	S3
D-1.3	S4
D-1.4	S10
Site 2: Burn Pit Beneath Pad	
D-2.1.1	S1
D-2.1.2	S4
D-2.1.3	S5
D-2.1.4	S10
D-2.1.5	S6
Site 2: Burn Pit - Perimeter of Pad	
D-2.2.1	S1
D-2.2.2	S6
D-2.2.3	S8
D-2.2.4	S10
Site 3: Revetment and Engine Test Pad Area	
D-3.1	S1
D-3.2	S6
D-3.3	S8
Site 4: Pump Station - AST Sites	
D-4.1.1	S1
D-4.1.2	S6
D-4.1.3	S8
D-4.1.4	S6/S7
D-4.1.5	S8/S7
D-4.1.6	S9/S7
D-4.1.7	S11/S7

Table	Remedial Alternative
Site 4: Pump Station - Soil Stockpile	
D-4.2.1	S1
D-4.2.2	S6
D-4.2.3	S8
Site 4: Pump Station - Sediment	
D-4.3.1	S1
D-4.3.2	S6/S7/S2
D-4.3.3	S8/S7/S2
D-4.3.4	S9/S7
D-4.3.5	S11/S7/S2
D-4.3.6	S12/S2
Site 5: Former Sewage Treatment Plant	
D-5.1	S1
D-5.2	S9/S7
D-5.3	S11/S7
D-5.4	S12
Site 6: East Levee Landfill	
D-6.1	S1
D-6.2	S6
D-6.3	S8
Site 7: Aircraft Maintenance and Storage Area - Soil	
D-7.1.1	S1
D-7.1.2	S6/S7/S2
D-7.1.3	S6/S12/S2
D-7.1.4	S8/S7/S2
D-7.1.5	S8/S12/S2
D-7.1.6	S7
D-7.1.7	S7
D-7.1.8	S12/S2
D-7.1.9	S2

Table	Remedial Alternative
Site 7: Aircraft Maintenance and Storage Area - Sediments	
D-7.2.1	S1
D-7.2.2	S6/S7/S2
D-7.2.3	S8/S7/S2
D-7.2.4	S9/S7
Site 8: Fuel Lines	
D-8.1	S1
D-8.2	S6
D-8.3	S8
Site 9: Building 442 AST	
D-9.1	S1
HAA Sites 2 through 8	
D-10	S6
D-11	S6/S7

Groundwater Cost Estimate Tables

Site 1: POL Area	
D-W1.1	GW1
D-W1.2	GW2
D-W1.3	GW4
D-W1.4	GW5
Site 2: Burn Pit	
D-W2.1	GW1
Site 3: Revetment	
D-W3.1	GW1
Site 4: Pump Station	
D-W4.1	GW1
Site 5: FSTP - Groundwater	
D-W5.1	GW1
D-W5.2	GW4
Site 6: East levee Landfill	
D-W6.1	GW1
Site 7: Aircraft Maintenance	
D-W7.1	GW1
D-W7.2	GW4
D-W7.3	GW5
D-W7.4	GW6
Site 8:Fuel Lines	
D-W8.1	GW1

Monitoring Cost Estimate Tables

DWM-1	Site 1: POL Area
DWM-2	Site 2: Burn Pit
DWM-3	Site 3: Reventment Area
DWM-4	Site 4: Pump Station Area
DWM-5a	Site 5: Former Sewage Treatment Plant
DWM-5b	Site 5: Former Sewage Treatment Plant
DWM-5c	Site 5: Former Sewage Treatment Plant
DWM-6	Site 6: East Levee Landfill
DWM-7	Site 7: Aircraft Maintenance
DWM-8	Site 8: Fuel Lines

Soil Cost Estimate Tables
for Wetland Option

Table	Remedial Alternative
Site 2: Burn Pit	
DF2.1	S1
DF2.2	S6/S2
DF2.3	S8/S2
Site 2: Reventment Area	
DF3.1	S1
DF3.2	S6/S2
DF3.3	S8/S2
Site 4:Pump Station	
DF4.1	S1
DF4.2	S6/S2
DF4.3	S8/S2
DF4.4	S6/S7/S2
DF4.5	S8/S7/S2
DF4.6	S9/S7/S2
DF4.7	S11/S7/S2
DF4.8	S12/S2
DF4.9	S9/S7/S2
DF4.10	S11/S7/S2
DF4.11	S12/S2
Site 5:Former Sewage Treatment Plant	
DF5.1	S1
DF5.2	S9/S7
DF5.3	S11/S7
DF5.4	S12/S2

Table	Remedial Alternative
Site 6:East Levee Landfill	
DF6.1	S1
DF6.2	S6/S7/S2
DF6.3	S8/S7/S2
Site 7:Aircraft Maintenance Soil	
DF7.1.1	S1
DF7.1.2	S6/S7/S2
DF7.1.3	S8/S7/S2
Site 7:Aircraft Maintenance Sediment	
DF7.2.1	S1
DF7.2.2	S6/S7/S2
DF7.2.3	S8/S7/S2
Site 8:Fuel Lines	
DF8.1	S1
DF8.2	S6/S7/S2
DF8.3	S8/S7/S2
HAA Sites 2 through 8	
DF10	S6/S2
DF-11	S6/S7/S2

REMEDIAL ALTERNATIVE CODES:

S1: No Action
S2: Capping
S3: In-situ Soil Flushing
S4 In-situ Bioremediation
S5: In-situ Soil Vapor Extraction
S6: Excavation and Biotreatment
S7: Excavation and Solidification/Stabilization
S8: Excavation and Low Temperature Thermal Desorption
S9: Excavation and Low Off-Site Thermal Destruction
S10: In-situ Bioventing
S11: Excavation and Chemical Oxidation
S12: Excavation and Soil Washing
GW.1 No Action
GW.2 Biostimulation
GW.4 Carbon Adsorption
GW.5 Biological treatment
GW.6 UV/Ozone

TABLE D–1.1
SITE 1: POL AREA
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling the 15 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B) Quarterly groundwater sampling and reporting only for 8 wells after first year.

(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five–year period.

(D) Project life assumed to be 30 years at 10% annual interest rate.

(E) Land use restrictions are necessary to warn and restrict receptor access.

(F) Operation and maintenance of land use restriction requires 30 years.

NOTE: This cost estimate is identical to Table DW–1.1, Site 1: POL Area, No Action Cost Estimate, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	12,000	1	12,000
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
(3)	Planning and regulatory compliance at 30%			0.3	3,600
(4)	Engineering and Supervision at 20%			0.2	2,400
(5)	Contingency at 20%			0.2	2,400
	TOTAL CAPITAL COST				$25,400
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	10,600	4	42,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr.	1,000	1	1,000
	Subtotal				$47,400
(4)	Contingency at 20%			0.2	9,480
	TOTAL ANNUAL O & M COST				$56,880
TOTAL PRESENT WORTH COSTS					$561,600

04/24/94

TABLE D-1.2
SITE 1: POL AREA
SOIL FLUSHING (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 20,490 yd^3

(B) 17 infiltration wells installed at $4,000 each and 7 recovery wells will be installed at $10,000.

(C) Soil flushing solution (surfactants) chemical cost assumed to be $8/$yd^3$. Labor assumed to be 20 hr/week.

(D) Effluent water from extraction wells will be treated using liquid phase GAC. Assume 6 units (2,000 lbs) will last for the project. Costs include shipping, setup and regeneration with carbon supplier. Assumed at $20,000 per year for O&M.

(E) Treatment unit includes piping, pumps, building and installation.

(F) Confirmation soil samples taken to monitor contamination removal from soil. (Costs include borehole installation, sampling and analysis.) Assumed at $500 per sample.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Infiltration well installation	well	4,000	17	68,000
	Recovery well installation	well	10,000	7	70,000
	Soil flushing effluent plant	ea.	30,000	1	30,000
			Subtotal		$168,000
(2)	Health and Safety at 10%			0.1	16,800
(3)	Engineering and Supervision at 30%			0.3	50,400
(4)	Contingency at 20%			0.2	33,600
			TOTAL CAPITAL COST		$268,800
ANNUAL OPERATIONS & MAINTENANCE, SOIL FLUSHING (0-2 YEARS)					
(1)	Soil Flushing System Operation				
	Labor (20 hr/wk)	hr	60	1,040	62,400
	Soil flushing treatment	yd^3	8	20,490	163,920
	GAC units (regeneration/transporation)	ea.	2,000	6	12,000
	General operations & maintenance	ea.	20,000	1	20,000
(2)	Confirmation soil sampling	ea.	500	15	7,500
			Subtotal		$265,820
(3)	Health and Safety at 10%			0.1	26,580
(4)	Engineering and Supervision at 30%			0.3	79,750
(5)	Contingency at 20%			0.2	53,160
			TOTAL ANNUAL O&M COST (0-2 YEARS)		$425,310

ANNUAL OPERATIONS & MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-1 for Groundwater Monitoring costs.

TOTAL PRESENT WORTH COSTS	$1,006,940

04/25/94

TABLE D-1.3
SITE 1: POL AREA
BIOREMEDIATION (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 20,490 yd^3

(B) 17 infiltration wells will be installed to supply oxygen and nutrients to the system at $4,000 per well, 7 recovery wells to be installed at $10,000 per well.

(C) Treatment unit (includes oxygenation system, nutrients storage, pumps and injection equipment) assumed to cost $40,000.

(D) Biotreatment costs assumed at $3/$yd^3$ for nutrients, 20 hrs. per week for labor ($60/hr), and general operations and maintenence at $15,000 per year.

(E) Confirmation soil samples to monitor contaminant degradation (cost includes borehole installation, sampling and analysis) estimated at $500 per sample.

(F) Remediation project life = 3 years

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Infiltration well installation	well	4,000	17	68,000
(2)	Recovery well installation	well	10,000	7	70,000
(3)	Treatment unit	ea.	40,000	1	40,000
			Subtotal		$178,000
(4)	Health and Safety at 10%			0.1	17,800
(5)	Engineering and Supervision at 30%			0.3	53,400
(6)	Contingency at 20%			0.2	35,600
		TOTAL CAPITAL COST			$284,800

ANNUAL OPERATIONS AND MAINTENANCE, BIOTREATMENT (0-3 YEARS)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Biotreatment operations				
	Labor (20 hr/wk)	hr	60	1,040	62,400
	General operations and maintenance	ea.	15,000	1	15,000
	Nutrients	yd^3	3	20,490	61,470
(2)	Confirmation soil sampling	ea.	500	15	7,500
			Subtotal		$146,370
(3)	Health and Safety at 10%			0.1	14,640
(4)	Engineering and Supervision at 30%			0.3	43,910
(5)	Contingency at 20%			0.2	29,270
	TOTAL ANNUAL O & M COST (0-3 YEARS)				$234,190

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

Refer to Table DWM-1 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $867,200

04/25/94

TABLE D-1.4
SITE 1: POL AREA
BIOVENTING (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A) Soil Volume = 20,490 yd^3

(B) Fourteen air injection wells and five vapor monitoring wells will be installed. Assume maximum depth of 8 ft at $3,000 per well.

(C) Air injection system includes piping, blower, and installation costs estimated at $17,000.

(D) Labor for operation and maintenance of treatment unit assumed to be 8 hours per week.

(E) Remediation project life = 3 years.

(F) Groundwater monitoring required for additional 1 year following remediation, at 4 samples per quarterly event.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Injection/Monitoring Wells	well	3,000	19	57,000
(2)	Air Injection System	ea.	15,000	1	15,000
			Subtotal		$72,000
(3)	Health and Safety at 10%			0.1	7,200
(4)	Engineering and Supervision at 20%			0.2	14,400
(5)	Contingency at 20%			0.2	14,400
			TOTAL CAPITAL COST		$108,000
ANNUAL OPERATIONS AND MAINTENANCE (0-3 YEARS)					
(1)	Air Injection Systems Operations				
	Labor (8 hr/wk)	hr	60	416	24,960
	General Operations & Maintanence	ea.	10,000	1	10,000
(2)	Confirmation Soil Sampling	ea.	500	15	7,500
			Subtotal		$42,460
(3)	Health and Safety at 10%			0.1	4,250
(4)	Engineering and Supervision at 20%			0.2	8,490
(5)	Contingency at 20%			0.2	8,490
			TOTAL ANNUAL O & M COST (0-3 YEARS)		$64,000

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (0-20 YEARS)

Refer to Table DWM-1 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $267,160

04/25/94

TABLE D-2.1.1
SITE 2: BURN PIT – BENEATH PAD
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(B) Quarterly sampling of 4 wells and summary report.
(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(D) Project life assumed to be 30 years at 10% annual interest rate.

NOTE: This cost estimate is identical to Table DW-2.1, Site 2: Burn Pit, No Action Cost Estimate, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Planning and regulatory compliance at 30%			0.3	2,940
(3)	Engineering and Supervision at 20%			0.2	1,960
(4)	Contingency at 20%			0.2	1,960
		TOTAL CAPITAL COST			$16,660
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs. Cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$43,200
(3)	Contingency at 20%			0.2	8,640
		TOTAL ANNUAL O & M COST			$51,800
TOTAL PRESENT WORTH COSTS					$504,970

04/24/94

TABLE D-2.1.2
SITE 2: BURN PIT- BENEATH PAD
BIOREMEDIATION (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 3,350 yd^3

(B)Four infiltration wells will be installed to supply oxygen and nutrients to the system. Assumed at $3,000 per well.

(C)Four recovery wells at $6,000 per well.

(D)Treatment unit (includes oxygenation system, nutrients storage, pumps and injection equipment) assumed to cost $10,000.

(E)Biotreatment costs assumed at $3/$yd^3$ for nutrients, 8 hrs. per week for labor ($60/hr), and general operations and maintenence at $2,000 per year.

(F)Confirmation soil samples to monitor contaminant degradation (cost includes borehole installation, sampling and analysis) estimated at $500 per sample.

(G)Remediation project life = 3 years

(H)The treated solution will be discharged to San Pablo Bay under base NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Infiltration well installation	well	3,000	4	12,000
(2)	Recovery well installation	well	6,000	4	24,000
(3)	Treatment unit	ea.	10,000	1	10,000
			Subtotal		$46,000
(4)	Health and Safety at 10%			0.1	4,600
(5)	Engineering and Supervision at 30%			0.3	13,800
(6)	Contingency at 20%			0.2	9,200
			TOTAL CAPITAL COST		$73,600
ANNUAL OPERATIONS AND MAINTENANCE, BIOTREATMENT (0-3 YEARS)					
(1)	Biotreatment operations				
	Nutrients	yd^3	3	3,350	10,050
	General operations and maintenance	ea.	5,000	1	5,000
	Labor (8 hr/wk)	hr	60	416	24,960
(2)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		$43,010
(3)	Health and Safety at 10%			0.1	4,300
(4)	Engineering and Supervision at 30%			0.3	12,900
(5)	Contingency at 20%			0.2	8,600
			TOTAL ANNUAL O&M COST (0-3 YEARS)		$68,810

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-2 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$244,720

04/24/94

TABLE D–2.1.3
SITE 2: BURN PIT – BENEATH PAD
SOIL VAPOR EXTRACTION (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A)Soil Volume = 3,350 yd^3

(B)Four vapor extraction wells will be installed. Assume maximum depth of 20 ft and $4,000 per well.

(C)Air injection system includes piping, blower, and installation costs estimated at $10,000.

(D)Exhaust soil gas will be treated using vapor phase granular activated carbon (GAC). Assume 6 GAC units (2,000 lbs.) will last for the project life. Costs include shipping, setup, and regeneration by GAC supplier at $4,000/unit.

(E)Air monitoring cost $5,000 per event.

(F)Labor for operation and maintenance of treatment unit assumed to be 8 hours per week.

(G)Remediation project life = 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Vapor Extraction Wells	well	4,000	4	16,000
(2)	Vacuum Extraction System	ea.	10,000	1	10,000
(3)	GAC units	ea.	4,000	6	24,000
			Subtotal		$50,000
(4)	Health and Safety at 10%			0.1	5,000
(5)	Engineering and Supervision at 20%			0.2	10,000
(6)	Contingency at 20%			0.2	10,000
		TOTAL CAPITAL COST			$75,000
ANNUAL OPERATIONS AND MAINTENANCE (0–2 YEARS)					
(1)	Air Injection Systems Operations				
	Labor (8 hr/wk)	hr	60	416	24,960
	Air Monitoring	event	5,000	4	20,000
	General Operations & Maintanence	ea.	5,000	1	5,000
(2)	Confirmation Soil Sampling	ea.	500	6	3,000
			Subtotal		$52,960
(3)	Health and Safety at 10%			0.1	5,300
(4)	Engineering and Supervision at 30%			0.3	15,890
(5)	Contingency at 20%			0.2	10,590
	TOTAL ANNUAL O & M COST (0–2 YEARS)				$85,000

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–2 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $222,520

04/24/94

TABLE D-2.1.4
SITE 2: BURN PIT – BENEATH PAD
BIOVENTING (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A)Soil Volume = 3,350 yd^3

(B)Two air injection wells and four vapor monitoring wells will be installed. Assume maximum depth of 8 ft at $3,000 per well.

(C)Air injection system includes piping, blower, and installation costs estimated at $10,000.

(D)Labor for operation and maintenance of treatment unit assumed to be 6 hours per week.

(E)Remediation project life = 3 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Injection/Monitoring Wells	well	3,000	6	18,000
(2)	Air Injection System	ea.	10,000	1	10,000
			Subtotal		$28,000
(3)	Health and Safety at 10%			0.1	2,800
(4)	Engineering and Supervision at 20%			0.2	5,600
(5)	Contingency at 20%			0.2	5,600
			TOTAL CAPITAL COST		$42,000
ANNUAL OPERATIONS AND MAINTENANCE (0–3 YEARS)					
(1)	Air Injection Systems Operations				
	Labor (6 hr/wk)	hr	60	312	18,720
	General Operations & Maintanence	ea.	5,000	1	5,000
(2)	Confirmation Soil Sampling	ea.	500	6	3,000
			Subtotal		$26,720
(3)	Health and Safety at 10%			0.1	2,670
(4)	Engineering and Supervision at 20%			0.2	5,340
(5)	Contingency at 20%			0.2	5,340
			TOTAL ANNUAL O & M COST (0–3 YEARS)		$40,000

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-2 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$141,470

04/24/94

TABLE D-2.1.5
SITE 2: BURN PIT – BENEATH PAD
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 3,350 yd^3

(B)Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 6 samples.

(D)Assume use of existing Revetment Pad.

(E)Treated soils will be returned to excavated area.

(F)Tilling once a week for project life period (8 hrs per week).

(G)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Remove concrete pad	ea.	20,000	1	20,000
(4)	Soil Excavation	yd^3	5	3,350	16,750
(5)	Backfill excavation site (at end of project)	yd^3	4	3,350	13,400
(6)	Decommission Groundwater Monitoring Wells	well	1,500	1	1,500
			Subtotal		$71,650
(7)	Health and Safety at 10%			0.1	7,165
(8)	Engineering and Supervision at 20%			0.2	14,330
(9)	Contingency at 20%			0.2	14,330
	TOTAL CAPITAL COST				$107,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	3,350	10,050
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	416	24,960
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		$38,010
(4)	Health and Safety at 10%			0.1	3,800
(5)	Engineering and Supervision at 20%			0.2	7,600
(6)	Contingency at 20%			0.2	7,600
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$57,010

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-2 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $205,940

04/24/94

TABLE D-2.2.1
SITE 2: BURN PIT - PERIMETER OF PAD
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(B) Quarterly sampling of 4 wells and summary report.
(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(D) Project life assumed to be 30 years at 10% annual interest rate.

NOTE: This cost estimate is identical to Table DW-2.1, Site 2: Burn Pit, No Action Cost Estimate, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Planning and regulatory compliance at 30%			0.3	2,940
(3)	Engineering and Supervision at 20%			0.2	1,960
(4)	Contingency at 20%			0.2	1,960
		TOTAL CAPITAL COST			$16,660
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs. Cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$43,200
(3)	Contingency at 20%			0.2	8,640
		TOTAL ANNUAL O & M COST			$51,800
TOTAL PRESENT WORTH COSTS					$504,970

04/28/94

TABLE D-2.2.2
SITE 2: BURN PIT – PERIMETER OF PAD
EXCAVATION AND BIOLOGICAL TREATMENT COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 2,590 yd^3

(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 6 samples.

(D) Assume use of existing Revetment Pad.

(E) Treated soils will be returned to excavated area.

(F) Tilling once a week for project life period (8 hrs per week).

(G) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Soil Excavation	yd^3	5	2,590	12,950
(4)	Decommission Groundwater Monitoring Wells	well	1,500	3	4,500
(5)	Backfill excavation site (at end of project)	yd^3	4	2,590	10,360
			Subtotal		$47,810
(6)	Health and Safety at 10%			0.1	4,781
(7)	Engineering and Supervision at 20%			0.2	9,562
(8)	Contingency at 20%			0.2	9,562
			TOTAL CAPITAL COST		$72,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	2,590	7,770
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	416	24,960
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		$35,730
(4)	Health and Safety at 10%			0.1	3,570
(5)	Engineering and Supervision at 20%			0.2	7,150
(6)	Contingency at 20%			0.2	7,150
			TOTAL ANNUAL O & M COST (0-2 YEARS)		$53,600

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-2 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$165,020

04/24/94

TABLE D-2.2.3
SITE 2: BURN PIT – PERIMETER OF PAD
LOW TEMPERATURE THERMAL DESORPTION
COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 2,590 yd^3.

(B)Low temperature thermal desorption to be completed by turn–key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C)Soils handling includes excavation, backfilling, compacting, and site regrade.

(D)Treated soil will be returned to excavated area.

(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 6 samples.

(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off–site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 3 units for project.

(G)Air monitoring costs $5,000 per event.

(H)Project life estimated at 4 months.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	25	2,590	64,750
(3)	Thermal Desorption	yd^3	100	2,590	259,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation Sampling	sample	500	6	3,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	3	6,000
(7)	Off–site recycle/disposal of organic phase liquids	ea.	1,500	2	3,000
(8)	Decommission Groundwater Monitoring Wells	well	1500	3	4,500
			Subtotal		$358,250
(9)	Health & Safety at 10%			0.1	35,830
(10)	Engineering and Supervision at 20%			0.2	71,650
(11)	Contingency at 20%			0.2	71,650
		TOTAL CAPITAL COST			$537,380

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–2 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $537,380

04/24/94

TABLE D-2.2.4
SITE 2: BURN PIT – PERIMETER OF PAD
BIOVENTING (IN SITU) COST ESTIMATE

ASSUMPTIONS:

(A) Soil Volume = 2,590 yd^3.

(B) Two air injection wells and four vapor monitoring wells will be installed. Assume maximum depth of 8 ft at $3,000 per well.

(C) Air injection system includes piping, blower, and installation costs estimated at $10,000.

(D) Labor for operation and maintenance of treatment unit assumed to be 6 hours per week.

(E) Remediation project life = 3 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Injection/Monitoring Wells	well	3,000	6	18,000
(2)	Air Injection System	ea.	10,000	1	10,000
			Subtotal		$28,000
(3)	Health and Safety at 10%			0.1	2,800
(4)	Engineering and Supervision at 20%			0.2	5,600
(5)	Contingency at 20%			0.2	5,600
			TOTAL CAPITAL COST		$42,000
ANNUAL OPERATIONS AND MAINTENANCE (0-3 YEARS)					
(1)	Air Injection Systems Operations				
	Labor (6 hr/wk)	hr	60	312	18,720
	General Operations & Maintanence	ea.	5,000	1	5,000
(2)	Confirmation Soil Sampling	ea.	500	6	3,000
			Subtotal		$26,720
(3)	Health and Safety at 10%			0.1	2,670
(4)	Engineering and Supervision at 20%			0.2	5,340
(5)	Contingency at 20%			0.2	5,340
			TOTAL ANNUAL O & M COST (0-3 YEARS)		$40,000
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM-2 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$141,470

04/24/94

TABLE D-3.1
SITE 3: REVETMENT AND ENGINE TEST PAD AREA
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Sampling the 3 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B)Quarterly groundwater sampling and reporting for 3 wells.

(C)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D)Project life assumed to be 30 years at 10% annual interest rate.

NOTE:This cost estimate is identical to Table DW-3.1, Site 3: Revetment Area, No Action Cost Estimate, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,600	1	9,600
(2)	Planning and regulatory compliance at 30%			0.3	2,880
(3)	Engineering and Supervision at 20%			0.2	1,920
(4)	Contingency at 20%			0.2	1,920
		TOTAL CAPITAL COST			$16,320
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment	yr.	20,000	0.2	4,000
	(One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)		Subtotal		$42,400
(3)	Contingency at 20%			0.2	8,480
		TOTAL ANNUAL O & M COST			$50,880
TOTAL PRESENT WORTH COSTS					$496,000

04/24/94

TABLE D-3.2
SITE 3: REVETMENT AND ENGINE TEST PAD AREA EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 66,000 yd^3

(B)Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation.

(D)Treated soils will be returned to excavated area.

(E)Tilling project life period (40 hrs per week).

(F)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	120,000	1	120,000
(3)	Soil Excavation	yd^3	5	66,000	330,000
(4)	Backfill excavation site (at end of project)	yd^3	4	66,000	264,000
(5)	Decommission Groundwater Monitoring Wells	well	2	1,500	3,000
			Subtotal		$722,000
(6)	Health and Safety at 10%			0.1	72,200
(7)	Engineering and Supervision at 20%			0.2	144,400
(8)	Contingency at 20%			0.2	144,400
	TOTAL CAPITAL COST				$1,083,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	66,000	198,000
(2)	Soils Handling (tilling, etc., 40 hr/wk)	hrs	60	2,100	126,000
(3)	Confirmation soil sampling	ea.	500	250	125,000
			Subtotal		$449,000
(4)	Health and Safety at 10%			0.1	44,900
(5)	Engineering and Supervision at 20%			0.2	89,800
(6)	Contingency at 20%			0.2	89,800
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$673,500
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM-3 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$2,251,880

04/24/94

TABLE D-3.3
SITE 3: REVETMENT AND ENGINE TEST PAD AREA EXCAVATION AND LOW TEMPERATURE THERMAL DESORPTION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 66,000 yd^3.

(B)Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $25,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C)Soils handling includes excavation, backfilling, compacting, and site regrade.

(D)Treated soil will be returned to excavated area.

(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process.

(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 57 units for project.

(G)Air monitoring costs $5,000 per event.

(H)Project life estimated at 1 year.

(I)Assume a lower unit cost ($80/$yd^3$) because of volume.

(J)No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads	ea.	25,000	1	25,000
(2)	Soils Handling	yd^3	25	66,000	1,650,000
(3)	Thermal Desorption	yd^3	80	66,000	5,280,000
(4)	Stack Air Monitoring	event	5,000	6	30,000
(5)	Confirmation Sampling	sample	500	250	125,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	250	500,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	30	45,000
(8)	Decommission Groundwater Monitoring Wells	well	1,500	2	3,000
			Subtotal		$7,658,000
(9)	Health & Safety at 10%			0.1	765,800
(10)	Engineering and Supervision at 20%			0.2	1,531,600
(11)	Contingency at 20%			0.2	1,531,600
			TOTAL CAPITAL COST		$11,487,000

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-3 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $11,487,000

04/24/94

TABLE D–4.1.1
SITE 4: PUMP STATION AREA – AST SITES
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 2 additional monitoring wells at $4,000 each.

(B)Sampling of the 1 existing well and 2 new wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(C)Quarterly groundwater sampling and reporting for 30 years, at 3 samples per event.

(D)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five–year period.

(E)Project life assumed to be 30 years at 10% annual interest rate.

(F)Land use restrictions are necessary to warn and restrict receptor access.

(G)Operation and maintenance of land use restriction requires 30 years.

NOTE:This cost estimate is identical to Table DW–4.1, Site 4: Pump Station Area – AST Sites, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	9,600	1	9,600
(5)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$22,600
(3)	Planning and regulatory compliance at 30%			0.3	6,780
(4)	Engineering and Supervision at 20%			0.2	4,520
(6)	Contingency at 20%			0.2	4,520
			TOTAL CAPITAL COST		$38,420
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$43,400
(4)	Contingency at 20%			0.2	8,680
			TOTAL ANNUAL O & M COST		$52,080
TOTAL PRESENT WORTH COSTS					$529,400

04/24/94

TABLE D-4.1.2
SITE 4: PUMP STATION AREA – AST SITES
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 180 yd^3 (AST-5 soils contaminated only with TPH).
(B) Application of nutrients and micro-organisms estimated at \$3/yd^3.
(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 4 samples.
(D) Assume use of existing Revetment Pad.
(E) Treated soils will be returned to excavated area.
(F) Tilling once a week for project life period (4 hrs per week).
(G) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	180	900
(4)	Backfill excavation site (at end of project)	yd^3	4	180	720
			Subtotal		\$16,620
(5)	Health and Safety at 10%			0.1	1,662
(6)	Engineering and Supervision at 20%			0.2	3,324
(7)	Contingency at 20%			0.2	3,324
	TOTAL CAPITAL COST				\$25,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	180	540
(2)	Soils Handling (tilling, etc., 4 hr/wk)	hrs	60	100	6,000
(3)	Confirmation soil sampling	ea.	500	4	2,000
			Subtotal		\$8,540
(4)	Health and Safety at 10%			0.1	850
(5)	Engineering and Supervision at 20%			0.2	1,710
(6)	Contingency at 20%			0.2	1,710
	TOTAL ANNUAL O & M COST (0-2 YEARS)				\$12,810
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM-4 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					\$47,230

04/24/94

TABLE D-4.1.3
SITE 4: PUMP STATION AREA – AST SITES
LOW TEMPERATURE THERMAL DESORPTION
COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 180 yd^3 (AST-5 soils contaminated only with TPH).

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, backfilling, compacting, and site regrade.

(D) Treated soil will be returned to excavated area.

(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 4 samples.

(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 2 units for project.

(G) Air monitoring costs $5,000 per event.

(H) Project life estimated at 4 months.

(I) No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	50	180	9,000
(3)	Thermal Desorption	yd^3	100	180	18,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	4	2,000
(6)	GAC Units(regeneration, transportation)	ea.	800	2	1,600
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Backfill excavation site	yd^3	4	180	720
			Subtotal		$50,820
(9)	Health & Safety at 10%			0.1	5,080
(10)	Engineering and Supervision at 20%			0.2	10,160
(11)	Contingency at 20%			0.2	10,160
		TOTAL CAPITAL COST			$76,220

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $76,220

04/24/94

TABLE D-4.1.4
SITE 4: PUMP STATION AREA - AST SITES
EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 300 yd^3 (AST-7 soils contaminated with TPH and metals).
(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.
(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 4 samples.
(D) Assume use of existing Revetment Pad.
(E) Treated soils will be returned to excavated area.
(F) Tilling once a week for project life period (4 hrs per week).
(G) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	300	1,500
(4)	Solidification Mobilization/Demobilization	ea.	5,000	1	5,000
(5)	Solidification equipment (year 2)	yd^3	30	300	9,000
(6)	Solidifcation agents (year 2)	yd^3	60	300	18,000
(7)	Backfill excavation site (year 2)	yd^3	4	300	1,200
			Subtotal		$49,700
(8)	Health and Safety at 10%			0.1	4,970
(9)	Engineering and Supervision at 20%			0.2	9,940
(10)	Contingency at 20%			0.2	9,940
		TOTAL CAPITAL COST			$75,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	300	900
(2)	Soils Handling (tilling, etc., 4 hr/wk)	hrs	60	208	12,480
(3)	Confirmation soil sampling	ea.	500	4	2,000
			Subtotal		$15,380
(4)	Health and Safety at 10%			0.1	1,540
(5)	Engineering and Supervision at 20%			0.2	3,080
(6)	Contingency at 20%			0.2	3,080
		TOTAL ANNUAL O & M COST (0-2 YEARS)			$23,080
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM-4 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$115,060

04/24/94

TABLE D-4.1.5
SITE 4: PUMP STATION AREA – AST SITES
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOLDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 300 yd^3 (AST–7 soils contaminated with TPH and metals).

(B) Low temperature thermal desorption to be completed by turn–key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, backfilling, compacting, and site regrade.

(D) Treated soil will be returned to excavated area.

(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 4 samples.

(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off–site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 2 units for project.

(G) Air monitoring costs $5,000 per event.

(H) Project life estimated at 4 months.

(I) No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	50	300	15,000
(3)	Thermal Desorption	yd^3	100	300	30,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	4	2,000
(6)	GAC Units(regeneration, transportation)	ea.	800	2	1,600
(7)	Off–site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Solidification Mobilization/Demobilization	ea.	5000	1	5,000
(9)	Solidification equipment	yd^3	30	300	9,000
(10)	Solidification agents	yd^3	60	300	18,000
(11)	Backfill excavation (year 2)	yd^3	4	300	1,200
			Subtotal		$101,300
(12)	Health & Safety at 10%			0.1	10,130
(13)	Engineering and Supervision at 20%			0.2	20,260
(14)	Contingency at 20%			0.2	20,260
			TOTAL CAPITAL COST		$151,950

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $151,950

04/24/94

TABLE D-4.1.6
SITE 4: PUMP STATION AREA – AST SITES
OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 180 yd^3 at 1.25 $tons/yd^3$ (AST-6 soils contaminated with TPH, SVOCs, and metals).
(B) Soil will be transported to Rollins Facility in Deer Park, Texas.
(C) Incineration costs assumed to be $0.60/lb ($1,200/ton)
(D) Transportation cost assumed to be $250/ton
(E) Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.
(F) No annual costs for this alternative. All costs incurred in first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	180	900
(3)	Transport to Off-site Facility	ton	250	225	56,250
(4)	Off-site Incineration	ton	1,200	225	270,000
(5)	Confirmation soil sampling	ea.	1,000	4	4,000
(6)	Backfill with onsite soils	yd^3	4	180	720
(7)	Solidification agents	yd^3	40	170	6,800
			Subtotal		$343,670
(8)	Engineering and Supervision at 10%			0.1	34,370
(9)	Contingency at 10%			0.1	34,370
		TOTAL CAPITAL COST			$412,410

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $412,410

04/24/94

TABLE D-4.1.7
SITE 4: PUMP STATION AREA - AST SITES
CHEMICAL OXIDATION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 180 yd^3 (AST-6; contaminated with TPH, SVOCS, and metals).
(B) Chemical oxidation equipment assumed to be standard process equipment and assumed at $20,000. Assume use of existing Revetment Pad.
(C) Chemical oxidation costs (agents and manpower) estimated at $50 per yd3.
(D) Soils placed in treatment unit after application to allow contaminant degradation. Assumed cost of unit = $10,000.
(E) Tilling soils once a week for project life of 4 months. (8 hrs. per week)
(F) Confirmation soil samples will be taken from the bottom of the excavation to ensure adequate contaminant removal and to monitor the treatment process. Assumed to include 20 samples.
(G) Treated soil will be returned to the excavation area.
(H) Extensive permitting costs are likely with this alternative.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Mobilization/Demobilization	ea.	10,000	1	10,000
	Chemical oxidation equipment	ea.	20,000	1	20,000
	Construction of treatment unit and storage pads	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	180	900
(3)	Chemical oxidation costs	yd^3	50	180	9,000
(4)	Soils Handling (mixing, etc., 8 hr/wk)	hr	60	416	24,960
(5)	Confirmation soil sampling	sample	1,000	4	4,000
(6)	Soil Excavation	yd^3	5	180	900
(7)	Solidification Mobilization/Demobilization	ea.	5,000	1	5,000
(8)	Solidification equipment	yd^3	30	170	5,100
(9)	Solidification agents	yd^3	60	170	10,200
(10)	Backfill excavation site	yd^3	4	180	720
			Subtotal		$100,780
(11)	Health and Safety at 10 %			0.1	10,080
(12)	Engineering and Supervision at 30%			0.3	30,230
(13)	Contingency at 20%			0.2	20,160
		TOTAL CAPITAL COST			$161,250

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table D-4.1 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $161,250

04/28/94

TABLE D–4.2.1
SITE 4: PUMP STATION AREA – SOIL STOCKPILE
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 2 additional monitoring wells at $4,000 each.
(B) Sampling of the 1 existing well and 2 new wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(C) Quarterly groundwater sampling and reporting for 30 years, at 3 samples per event.
(D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five–year period.
(E) Project life assumed to be 30 years at 10% annual interest rate.
(F) Land use restrictions are necessary to warn and restrict receptor access.
(G) Operation and maintenance of land use restriction requires 30 years.

NOTE: This cost estimate is identical to Table DW–4.1, Site 4: Pump Station Area – AST Sites, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	9,600	1	9,600
(5)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$22,600
(3)	Planning and regulatory compliance at 30%			0.3	6,780
(4)	Engineering and Supervision at 20%			0.2	4,520
(6)	Contingency at 20%			0.2	4,520
	TOTAL CAPITAL COST				$38,420
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$43,400
(4)	Contingency at 20%			0.2	8,680
	TOTAL ANNUAL O & M COST				$52,080
TOTAL PRESENT WORTH COSTS					$529,400

04/24/94

TABLE D-4.2.2
SITE 4: PUMP STATION AREA – SOIL STOCKPILE EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 710 yd^3 (stockpile and USTs soils contaminated only with TPH)
(B)Application of nutrients and micro-organisms estimated at $3/$yd^3$.
(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 7 samples.
(D)Assume use of existing Revetment Pad.
(E)Treated soils will be returned to excavated area.
(F)Tilling once a week for project life period (8 hrs per week).
(G)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	710	3,550
(4)	Backfill excavation site (at end of project)	yd^3	4	710	2,840
			Subtotal		$21,390
(5)	Health and Safety at 10%			0.1	2,139
(6)	Engineering and Supervision at 20%			0.2	4,278
(7)	Contingency at 20%			0.2	4,278
		TOTAL CAPITAL COST			$32,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	710	2,130
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	412	24,720
(3)	Confirmation soil sampling	ea.	500	7	3,500
			Subtotal		$30,350
(4)	Health and Safety at 10%			0.1	3,040
(5)	Engineering and Supervision at 20%			0.2	6,070
(6)	Contingency at 20%			0.2	6,070
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$45,530
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM-4 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$111,020

04/24/94

TABLE D-4.2.3
SITE 4: PUMP STATION AREA – SOIL STOCKPILE
LOW TEMPERATURE THERMAL DESORPTION
COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 710 yd^3 (stockpile and USTs soil contaminated with TPH, metals, pesticides).

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, backfilling, compacting, and site regrade.

(D) Treated soil will be returned to excavated area.

(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 7 samples.

(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 3 units for project.

(G) Air monitoring costs $5,000 per event.

(H) Project life estimated at 4 months.

(I) No annual costs for this project. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	25	710	17,750
(3)	Thermal Desorption	yd^3	100	710	71,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	7	3,500
(6)	GAC Units(regeneration, transportation)	ea.	800	3	2,400
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
			Subtotal		$114,150
(8)	Health & Safety at 10%			0.1	11,420
(9)	Engineering and Supervision at 20%			0.2	22,830
(10)	Contingency at 20%			0.2	22,830
	TOTAL CAPITAL COST				$171,230

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $171,230

04/24/94

TABLE D-4.3.1
SITE 4: PUMP STATION AREA – SEDIMENTS
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 2 additional monitoring wells at $4,000 each.

(B)Sampling of the 1 existing well and 2 new wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(C)Quarterly groundwater sampling and reporting for 30 years, at 3 samples per event.

(D)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(E)Project life assumed to be 30 years at 10% annual interest rate.

(F)Land use restrictions are necessary to warn and restrict receptor access.

(G)Operation and maintenance of land use restrictions requires 30 years.

NOTE:This cost estimate is identical to Table DW-4.1, Site 4: Pump Station Area, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	9,600	1	9,600
(3)	Land Use Restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$22,600
(4)	Planning and regulatory compliance at 30%			0.3	6,780
(5)	Engineering and Supervision at 20%			0.2	4,520
(6)	Contingency at 20%			0.2	4,520
	TOTAL CAPITAL COST				$38,420
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
(3)	Land use restriction maintenance				1,000
			Subtotal		$43,400
(4)	Contingency at 20%			0.2	8,680
	TOTAL ANNUAL O & M COST				$52,080
TOTAL PRESENT WORTH COSTS					$529,400

04/24/94

TABLE D-4.3.2
SITE 4: PUMP STATION AREA – SEDIMENTS EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 460 yd^3 (soils contaminated with TPH, metals); cover material volume = 690 yd^3.

(B)Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 6 samples.

(D)Assume use of existing Revetment Pad.

(E)Tilling once a week for project life period (6 hrs per week).

(F)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	460	2,300
(4)	Solidification equipment Mobilization/Demobilization	ea.	5000	1	5,000
(5)	Solidification equipment (year 2)	yd^3	30	460	13,800
(6)	Solidification agents (year 2)	yd^3	60	460	27,600
(7)	Land disposal of treated sediment (year 2)	yd^3	4	460	1,840
(8)	Apply cover material (year 2)	yd^3	4	690	2,760
			Subtotal		$68,300
(9)	Health and Safety at 10%			0.1	6,830
(10)	Engineering and Supervision at 20%			0.2	13,660
(11)	Contingency at 20%			0.2	13,660
	TOTAL CAPITAL COST				$102,000
ANNUAL OPERATIONS AND MAINTENANCE (0–2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	460	1,380
(2)	Soils Handling (tilling, etc., 6 hr/wk)	hrs	60	312	18,720
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		$23,100
(4)	Health and Safety at 10%			0.1	2,310
(5)	Engineering and Supervision at 20%			0.2	4,620
(6)	Contingency at 20%			0.2	4,620
	TOTAL ANNUAL O & M COST (0–2 YEARS)				$34,650

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$162,140

04/24/94

TABLE D-4.3.3
SITE 4: PUMP STATION AREA - SEDIMENTS
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 460 yd^3 (TPH, metals); cover material volume = 690 yd^3.

(B)Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C)Soils handling includes excavation, land disposal, applying 3 feet of cover material, compacting, and site regrade.

(D)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 6 samples.

(E)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 2 units for project.

(F)Air monitoring costs $5,000 per event.

(G)Project life estimated at 6 months.

(H)Solidification equipment Mobilization/Demobilization estimated $5,000.

(I)Addition of solidification agents assumed at $60/$yd^3$.

(J)Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $20/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	25	460	11,500
(3)	Thermal Desorption	yd^3	100	460	46,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	6	3,000
(6)	GAC Units(regeneration, transportation)	ea.	800	2	1,600
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Solidification equipment Mobilization/Demobilization	ea.	5000	1	5,000
(9)	Solidification equipment	yd^3	30	460	13,800
(10)	Solidification agents	yd^3	60	460	27,600
(11)	Land disposal of treated sediment	yd^3	4	460	1,840
(12)	Apply cover material	yd^3	4	690	2,760
			Subtotal		$132,600
(13)	Health & Safety/ Air Monitoring at 10%			0.1	13,260
(14)	Engineering and Supervision at 30%			0.3	39,780
(15)	Contingency at 20%			0.2	26,520
		TOTAL CAPITAL COST			$212,160

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $212,160

04/25/94

TABLE D-4.3.4
SITE 4: PUMP STATION AREA - SEDIMENTS
OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 22,220 yd^3 at 1.25 tons/yd^3 (TPH, metals, pesticides); cover material volume = 33,330 yd^3

(B) Soil will be transported to Rollins Facility in Deer Park, Texas.

(C) Incineration costs assumed to be $0.60/lb ($1,200/ton).

(D) Transportation cost assumed to be $250/ton.

(E) Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.

(F) No annual costs for this alternative. All costs incurred in first year.

(G) Addition of solidification agents assumed at $40/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	22,220	111,100
(3)	Transport to off-site facility	ton	250	27,780	6,945,000
(4)	Off-site Incineration	ton	1,200	27,780	33,336,000
(5)	Confirmation soil sampling	ea.	1,000	200	200,000
(6)	Apply cover material	yd^3	4	33,330	133,320
(7)	Solidification agents	yd^3	40	22,220	888,800
			Subtotal		$41,619,220
(8)	Engineering and Supervision at 10%			0.1	4,161,920
(9)	Contingency at 20%			0.2	8,323,840
			TOTAL CAPITAL COST		**$54,104,980**

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS **$54,104,980**

05/05/94

TABLE D-4.3.5
SITE 4: PUMP STATION AREA – SEDIMENTS CHEMICAL OXIDATION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 22,220 yd^3 (contaminated with TPH, metals, pesticides); cover material volume = 33,330 yd^3.

(B) Chemical oxidation equipment assumed to be standard process equipment and assumed at $20,000. Assume use of existing Revetment Pad.

(C) Chemical oxidation costs (agents and manpower) estimated at $50 per yd^3.

(D) Soils placed in treatment unit after application to allow contaminant degradation. Assumed cost of unit = $20,000.

(E) Tilling soils once a week for project life of 6 months. (8 hrs. per week)

(F) Confirmation soil samples will be taken from the bottom of the excavation to ensure adequate contaminant removal and to monitor the treatment process. Assumed to include 10 samples.

(G) Treated soil will be returned to the excavation area.

(H) Addition of solidification agents assumed at $50/$yd^3$.

(I) Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $20/$yd^3$.

(J) Extensive permitting costs are likely with this alternative.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Mobilization/Demobilization	ea.	10,000	1	10,000
	Chemical oxidation equipment	ea.	20,000	1	20,000
	Construction of treatment unit and storage pads	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	22,220	111,100
(3)	Chemical oxidation costs	yd^3	50	22,220	1,111,000
(4)	Soils Handling (mixing, etc., 40 hr/wk)	hr	60	2,080	124,800
(5)	Confirmation soil sampling	sample	1,000	200	200,000
(6)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(7)	Solidification equipment operation	yd^3	30	22,220	666,600
(8)	Solidification agents	yd^3	60	22,220	1,333,200
(9)	Land disposal of treated sediment	yd^3	4	22,220	88,880
(10)	Apply cover material	yd^3	4	33,330	133,320
			Subtotal		$3,813,900
(10)	Health and Safety at 10 %			0.1	381,390
(11)	Engineering and Supervision at 30%			0.3	1,144,170
(12)	Contingency at 20%			0.2	762,780
		TOTAL CAPITAL COST			$6,102,240

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $6,102,240

04/24/94

TABLE D–4.3.6
SITE 4: PUMP STATION – SEDIMENTS
SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 22,220 yd^3 (soil contaminated with TPH, metals, pesticides); cover material volume = 33,330 yd^3.

(B) Soil washing to be completed by turn–key contractor. Two washes required, one for organics and one for metals.

(C) Soil washing costs (solvent and manpower) estimated at \$100/yd^3 for first wash, \$30/yd^3 for second wash

(D) Confirmation samples taken from bottom of excavation to ensure adequate contamination removal and to monitor treatment process. Assumed 200 samples.

(E) Treated soil will be returned to excavated area.

(F) Project life estimated to be 12 months.

(G) No annual costs for this alternative. All costs incurred in first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	mobilization/demobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	22,220	111,100
(3)	Soil Washing Equipment Rental	month	10,000	12	120,000
(4)	Soil Washing Costs				
	(solvent and manpower)	yd^3	130	22,220	2,888,600
(5)	Confirmation samples	ea.	1,000	200	200,000
(6)	Land disposal of treated sediment	yd^3	4	22,220	88,880
(7)	Apply cover material	yd^3	4	33,330	133,320
			Subtotal		\$3,546,900
(7)	Health and Safety at 10%			0.1	354,690
(8)	Engineering and Supervision at 30%			0.3	1,064,070
(9)	Contingency at 20%			0.2	709,380
			TOTAL CAPITAL COST		\$5,675,040

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS \$5,675,040

04/24/94

TABLE D–5.1
SITE 5: FORMER SEWAGE TREATMENT PLANT
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 2 additional monitoring wells at $4,000 each.

(B)Sampling of the 1 existing well and 2 new wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(C)Quarterly groundwater sampling and reporting for 30 years, at 3 samples per event.

(D)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five–year period.

(E)Project life assumed to be 30 years at 10% annual interest rate.

(F)Land use restrictions are necessary to warn and restrict receptor access.

(G)Operation and maintenance of land use restriction requires 30 years.

NOTE:This cost estimate is identical to Table DW–5.1, Site 5: Former Sewage Treatment Plant, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	9,600	1	9,600
(5)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$22,600
(3)	Planning and regulatory compliance at 30%			0.3	6,780
(4)	Engineering and Supervision at 20%			0.2	4,520
(6)	Contingency at 20%			0.2	4,520
		TOTAL CAPITAL COST			$38,420
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$43,400
(4)	Contingency at 20%			0.2	8,680
		TOTAL ANNUAL O & M COST			$52,080
TOTAL PRESENT WORTH COSTS					$529,400

04/24/94

TABLE D-5.2
SITE 5: FORMER SEWAGE TREATMENT PLANT
OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 1,200 yd^3 at 1.25 tons/yd^3 (TPH, PCBs, pesticides, metals).
(B) Soil will be transported to Rollins Facility in Deer Park, Texas.
(C) Incineration costs assumed to be $0.60/lb ($1,200/ton)
(D) Transportation cost assumed to be $250/ton
(E) Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.
(F) No annual costs for this alternative. All costs incurred in first year.
(G) Addition of solidification agents assumed at $40/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation (mobilization)	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	1,200	6,000
(3)	Transport to Off-site Facility	ton	250	1,500	375,000
(4)	Off-site Incineration	ton	1,200	1,500	1,800,000
(5)	Confirmation soil sampling	sample	1,000	8	8,000
(6)	Backfill with onsite soils	yd^3	4	1,200	4,800
(7)	Solidification agents	yd^3	40	1,200	48,000
			Subtotal		$2,246,800
(8)	Engineering and Supervision at 10%			0.1	224,680
(9)	Contingency at 10%			0.1	224,680
		TOTAL CAPITAL COST			$2,696,160

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-5 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$2,696,160

04/25/94

TABLE D-5.3
SITE 5: FORMER SEWAGE TREATMENT PLANT
CHEMICAL OXIDATION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 1,200 yd^3 (TPH, PCBs, pesticides, metals).

(B) Chemical oxidation equipment assumed to be standard process equipment, and assumed at $20,000.

(C) Chemical oxidation costs (agents and manpower) estimated at $50 per yd^3.

(D) Soils placed in treatment unit after application to allow contaminant degradation. Assumed cost of unit = $10,000.

(E) Mixing soils 16 hrs per week. Project life of 6 months.

(F) Confirmation soil samples will be taken from the bottom of the excavation to ensure adequate contaminant removal and to monitor the treatment process. Assumed to include 10 samples.

(G) Treated soil will be returned to the excavation area.

(H) Extensive permitting costs are likely with this alternative.

(I) Soilification equipment includes screening, shredding, and pugmil with assumed rental costs at $30/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Mobilization/Demobilization	ea.	10,000	1	10,000
	Chemical oxidation equipment	ea.	20,000	1	20,000
	Construction of treatment unit and storage pads	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	1,200	6,000
(3)	Chemical oxidation costs	yd^3	50	1,200	60,000
(4)	Soils Handling (mixing, etc., 16 hr/wk)	hr	60	832	49,920
(5)	Confirmation soil sampling	sample	1,000	10	10,000
(6)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(7)	Solidification equipment operation	yd^3	30	560	16,800
(8)	Solidification agents	yd^3	60	560	33,600
(9)	Backfill excavation site	yd^3	4	1,200	4,800
			Subtotal		$226,120
(10)	Health and Safety at 10 %			0.1	22,610
(11)	Engineering and Supervision at 30%			0.3	67,840
(12)	Contingency at 20%			0.2	45,220
			TOTAL CAPITAL COST		$361,790

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-5 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$361,790

04/24/94

TABLE D-5.4
SITE 5: FORMER SEWAGE TREATMENT PLANT
SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 1,200 yd^3 (TPH, PCBs, pesticides, metals).
(B) Soil washing to be completed by turn-key contractor. Two washes required, one for organics and one for metals.
(C) Soil washing costs (solvent and manpower) estimated at \$100/yd^3 for first wash, \$30/yd^3 for second wash.
(D) Confirmation samples taken from bottom of excavation to ensure adequate contamination removal and to monitor treatment process. Assumed 10 samples.
(E) Treated soil will be returned to excavated area.
(F) Project life estimated to be 6 months.
(G) No annual costs for this alternative. All costs incurred in first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	mobilization/demobilization	ea.	5,000	1	5,000
	construction of treatment and storage pad	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	1,200	6,000
(3)	Soil Washing Equipment Rental	month	10,000	6	60,000
(4)	Soil Washing Costs				
	(solvent and manpower)	yd^3	130	1,200	156,000
(5)	Confirmation samples	sample	1,000	10	10,000
(6)	Backfill excavation site	yd^3	4	1,200	4,800
			Subtotal		\$251,800
(7)	Health and Safety at 10%			0.1	25,180
(8)	Engineering and Supervision at 30%			0.3	75,540
(9)	Contingency at 20%			0.2	50,360
		TOTAL CAPITAL COST			\$402,880

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-5 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS \$402,880

04/26/94

TABLE D-6.1
SITE 6: EAST LEVEE LANDFILL
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Sampling the 5 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B)Quarterly groundwater sampling and reporting for 5 wells.

(C)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D)Project life assumed to be 30 years at 10% annual interest rate.

NOTE:This cost estimate is identical to Table DW-6.1, Site 6: East Levee Landfill, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	10,000	1	10,000
(2)	Planning and regulatory compliance at 30%			0.3	3,000
(3)	Engineering and Supervision at 20%			0.2	2,000
(4)	Contingency at 20%			0.2	2,000
		TOTAL CAPITAL COST			$17,000
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	10,000	4	40,000
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$44,000
(3)	Contingency at 20%			0.2	8,800
		TOTAL ANNUAL O & M COST			$52,800
TOTAL PRESENT WORTH COSTS					$514,700

04/24/94

TABLE D-6.2
SITE 6: EAST LEVEE LANDFILL
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 5,000 yd^3

(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 20 samples.

(D) Treated soils will be returned to excavated area.

(E) Tilling project life period (12 hrs per week).

(F) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	100,000	1	100,000
(3)	Soil Excavation	yd^3	5	5,000	25,000
(4)	Backfill excavation site (at end of project)	yd^3	4	5,000	20,000
(5)	Decommission Groundwater Monitoring Wells	well	1,500	3	4,500
			Subtotal		$154,500
(6)	Health and Safety at 10%			0.1	15,450
(7)	Engineering and Supervision at 20%			0.2	30,900
(8)	Contingency at 20%			0.2	30,900
		TOTAL CAPITAL COST			$232,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	5,000	15,000
(2)	Soils Handling (tilling, etc., 12 hr/wk)	hr.	60	624	37,440
(3)	Confirmation soil sampling	ea.	500	20	10,000
			Subtotal		$62,440
(4)	Health and Safety at 10%			0.1	6,240
(5)	Engineering and Supervision at 20%			0.2	12,490
(6)	Contingency at 20%			0.2	12,490
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$93,660
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DMW-6 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$394,550

04/25/94

TABLE D-6.3
SITE 6: EAST LEVEE LANDFILL
EXCAVATION AND LOW TEMPERATURE THERMAL DESORPTION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 5,000 yd^3.

(B)Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $25,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C)Soils handling includes excavation, backfilling, compacting, and site regrade.

(D)Treated soil will be returned to excavated area.

(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 10 samples.

(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 5 units for project.

(G)Air monitoring costs $5,000 per event.

(H)Project life estimated at 4 months.

(I)No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				25,000
(2)	Soils Handling	yd^3	25	5,000	125,000
(3)	Decommission Groundwater Monitoring Wells	well	1,500	3	4,500
(4)	Thermal Desorption	yd^3	100	5,000	500,000
(5)	Stack Air Monitoring	event	5,000	2	10,000
(6)	Confirmation Sampling	sample	500	20	10,000
(7)	GAC Units(regeneration, transportation)	ea.	2,000	5	10,000
(8)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	3	4,500
			Subtotal		$689,000
(9)	Health & Safety at 10%			0.1	68,900
(10)	Engineering and Supervision at 20%			0.2	137,800
(11)	Contingency at 20%			0.2	137,800
	TOTAL CAPITAL COST				$1,033,500

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DMW-6 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $1,033,500

04/24/94

TABLE D-7.1.1
SITE 7: AIRCRAFT MAINTENANCE SOIL
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B)Quarterly groundwater sampling and reporting for 30 years, at 4 samples per event.

(C)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D)Project life assumed to be 30 years at 10% annual interest rate.

(E)Land use restrictions are necessary to warn and restrict receptor access.

(F)Operation and maintenance of land use restriction requires 30 years.

NOTE:This cost estimate is identical to Table DW-7.1, Site 7: Aircraft Maintenance Soil, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$14,800
(3)	Planning and regulatory compliance at 30%			0.3	4,440
(4)	Engineering and Supervision at 20%			0.2	2,960
(5)	Contingency at 20%			0.2	2,960
			TOTAL CAPITAL COST		$25,160
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$44,200
(4)	Contingency at 20%			0.2	8,840
			TOTAL ANNUAL O & M COST		$53,040
TOTAL PRESENT WORTH COSTS					$525,200

04/24/94

TABLE D-7.1.2
SITE 7: AIRCRAFT MAINTENANCE SOIL EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 1,940 yd^3 (soils contaminated with TPH, metals); cover material = 68,600 yd^3.
(B) Application of nutrients and micro-organisms estimated at \$3/yd^3.
(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 20 samples.
(D) Assume the use of an existing Pad.
(E) Treated soils will be returned to excavated area.
(F) Tilling once a week for project life period (16 hrs per week).
(G) Project life estimated at 2 years.
(H) Cap unpaved areas with 3 feet of non-engineered fill.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Soil Excavation	yd^3	5	1,940	9,700
(4)	Solidification Mobilization/Demobilization	ea.	5,000	1	5,000
(5)	Solidification equipment (year 2)	yd^3	30	1,940	58,200
(6)	Solidification agents (year 2)	yd^3	60	1,940	116,400
(7)	Decommission Groundwater Monitoring Wells	well	1,500	4	6,000
(8)	Cap with 3 feet of fill	yd^3	4	68,600	274,400
			Subtotal		\$489,700
(9)	Health and Safety at 10%			0.1	48,970
(10)	Engineering and Supervision at 20%			0.2	97,940
(11)	Contingency at 20%			0.2	97,940
	TOTAL CAPITAL COST				\$735,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	1,940	5,820
(2)	Soils Handling (tilling, etc., 16 hr/wk)	hrs	60	832	49,920
(3)	Confirmation soil sampling	ea.	500	20	10,000
			Subtotal		\$65,740
(4)	Health and Safety at 10%			0.1	6,570
(5)	Engineering and Supervision at 20%			0.2	13,150
(6)	Contingency at 20%			0.2	13,150
	TOTAL ANNUAL O & M COST (0-2 YEARS)				\$98,610

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS \$906,140

04/26/94

TABLE D–7.1.3
SITE 7: AIRCRAFT MAINTENANCE SOIL EXCAVATION AND BIOTREATMENT FOLLOWED BY SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 1,940 yd^3 (soils contaminated with TPH, metals); cover material = 68,600 yd^3.

(B)Application of nutrients and micro–organisms estimated at $3/$yd^3$.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 10 samples.

(D)Soil washing costs (solvent and manpower) estimated at $100/$yd^3$, and would take 8 months.

(E)Treated soils will be returned to excavated area.

(F)Tilling once a week for project life period (8 hrs per week).

(G)Project life estimated at 2 years.

(H)Cap unpaved areas with 3 feet of non–engineered fill.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Soil Excavation	yd^3	5	1,940	9,700
(4)	Soil washing equipment rental (year 2)	month	10,000	8	80,000
(5)	Soil washing solvents and manpower (year 2)	yd^3	100	1,940	194,000
(6)	Decommission Groundwater Monitoring Wells	well	1,500	4	6,000
(7)	Cap with 3 feet of fill	yd^3	4	68,600	274,400
			Subtotal		$584,100
(8)	Health and Safety at 10%			0.1	58,410
(9)	Engineering and Supervision at 30%			0.3	175,230
(10)	Contingency at 20%			0.2	116,820
			TOTAL CAPITAL COST		$935,000
ANNUAL OPERATIONS AND MAINTENANCE (0–2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	1,940	5,820
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	416	24,960
(3)	Confirmation soil sampling	ea.	500	20	10,000
			Subtotal		$40,780
(4)	Health and Safety at 10%			0.1	4,080
(5)	Engineering and Supervision at 20%			0.2	8,160
(6)	Contingency at 20%			0.2	8,160
			TOTAL ANNUAL O & M COST (0–2 YEARS)		$61,180

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$1,041,180

04/26/94

TABLE D–7.1.4
SITE 7: AIRCRAFT MAINTENANCE – SOIL
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

(A)Contaminated soil volume = 1,940 yd^3 (TPH, metals); cover material = 68,600 yd^3.
(B)Low temperature thermal desorption to be completed by turn–key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing pad.
(C)Soils handling includes excavation, backfilling, compacting, and site regrade.
(D)Treated soil will be returned to excavated area.
(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 10 samples.
(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off–site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 2 units for project.
(G)Project life estimated at 6 months.
(H)Addition of solidification agents assumed at $60/$yd^3$.
(I)Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $30/$yd^3$.
(J)Cap unpaved areas with 3 feet of non–engineered fill.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				10,000
(2)	Soils Handling	yd^3	25	1,940	48,500
(3)	Thermal Desorption	yd^3	150	1,940	291,000
(4)	Stack Air Monitoring	sample	500	10	5,000
(5)	Confirmation soil sampling	sample	500	20	10,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	2	4,000
(7)	Off–site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Solidification equipment	yd^3	20	1,940	38,800
(9)	Solidification agents	yd^3	50	1,940	97,000
(10)	Decommission Groundwater Monitoring Wells	well	1,500	4	6,000
(11)	Cap with 3 feet of fill	yd^3	4	68,600	274,400
			Subtotal		$786,200
(12)	Health & Safety/ Air Monitoring at 10%			0.1	78,620
(13)	Engineering and Supervision at 30%			0.3	235,860
(14)	Contingency at 20%			0.2	157,240
	TOTAL CAPITAL COST				$1,257,920

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $1,257,920

04/26/94

TABLE D-7.1.5
SITE 7: AIRCRAFT MAINTENANCE – SOIL
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 1,940 yd^3 (TPH, metals); cover material = 68,600 yd^3.

(B)Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $10,000 to include mobilization/demobilization and construction as needed.

(C)Soils handling includes excavation, backfilling, compacting, and site regrade.

(D)Treated soil will be returned to excavated area.

(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 6 samples.

(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $1,500 per unit. Assume 2 units for project.

(G)Project life estimated at 6 months.

(H)Soil washing costs (solvent and manpower) estimated at $100/$yd^3$.

(I)Cap unpaved areas with 3 feet of non-engineered fill.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				10,000
(2)	Soils Handling	yd^3	25	1,940	48,500
(3)	Thermal Desorption	yd^3	100	1,940	194,000
(4)	Stack Air Monitoring	event	5,000	3	15,000
(5)	Confirmation soil sampling	sample	500	20	10,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	2	4,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Soil washing equipment rental	month	10,000	6	60,000
(9)	Soil washing costs	yd^3	100	1,940	194,000
(10)	Decommission Groundwater Monitoring Wells	well	1,500	4	6,000
(11)	Cap with 3 feet of fill	yd^3	4	68,600	274,400
			Subtotal		$817,400
(12)	Health & Safety at 10%			0.1	81,740
(13)	Engineering and Supervision at 30%			0.3	245,220
(14)	Contingency at 20%			0.2	163,480
	TOTAL CAPITAL COST				$1,307,840

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $1,307,840

04/26/94

TABLE D-7.1.6
SITE 7: AIRCRAFT MAINTENANCE – SOILS
SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 40 yd^3 (soils near Storage Area 3 contaminated with Arsenic and Beryllium).

(B)Solidification by turn-key contractor.

(C)Addition of solidification agents assumed at \$60/yd^3.

(D)Treated soils will be returned to excavated area.

(E)Confirmation soil samples will be taken at bottom of excavation to monitor solidification/stabilization effectiveness.

(F)Equipment includes screening, shredding, and pugmill with assumed rental costs at \$30/yd^3.

(G)Project life estimated less than 1 year.

(H)Costs for covering the site are included in tables D-7.1.2 through D-7.1.5

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Soil Excavation	yd^3	5	40	200
(3)	Backfill excavation site	yd^3	4	40	160
(4)	Confirmation soil sampling	ea.	500	5	2,500
(5)	Solidification equipment	yd^3	30	40	1,200
(6)	Solidification agents	yd^3	60	40	2,400
			Subtotal		\$11,460
(7)	Health and Safety at 10%			0.1	1,150
(8)	Engineering and Supervision at 20%			0.2	2,290
(9)	Contingency at 20%			0.2	2,290
		TOTAL CAPITAL COST			\$17,190

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	\$17,190

04/24/94

TABLE D-7.1.7
SITE 7: AIRCRAFT MAINTENANCE - SOILS
SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 147,780 yd^3 (contaminated with Beryllium only).
(B)Solidification by turn-key contractor.
(C)Addition of solidification agents assumed at $60/$yd^3$.
(D)Treated soils will be returned to excavated area.
(E)Confirmation soil samples will be taken at bottom of excavation to monitor solidification/stabilization effectiveness.
(F)Equipment includes screening, shredding, and pugmill with assumed rental costs at $30/$yd^3$.
(F)Project life estimated less than 1 year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Soil Excavation	yd^3	5	147,780	738,900
(3)	Backfill excavation site	yd^3	4	147,780	591,120
(4)	Confirmation soil sampling	ea.	500	300	150,000
(5)	Solidification equipment	yd^3	30	147,780	4,433,400
(6)	Solidification agents	yd^3	60	147,780	8,866,800
			Subtotal		$14,785,220
(7)	Health and Safety at 10%			0.1	1,478,520
(8)	Engineering and Supervision at 20%			0.2	2,957,040
(9)	Contingency at 20%			0.2	2,957,040
		TOTAL CAPITAL COST			$22,177,820

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $22,177,820

04/25/94

TABLE D-7.1.8
SITE 7: AIRCRAFT MAINTENANCE – SOILS
SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 1,940 yd^3 (TPH, metals); cover material = 68,600 yd^3.

(B)Soil washing to be completed by turn-key contractor. Two washes required, one for organics and one for metals.

(C)Soil washing costs (solvent and manpower) estimated at \$100/yd^3 for first wash and \$30/yd^3 for the second wash.

(D)Confirmation samples taken from bottom of excavation to ensure adequate contamination removal and to monitor treatment process. Assumed 10 samples.

(E)Treated soil will be returned to excavated area.

(F)Project life estimated to be 10 months.

(G)No annual costs for this alternative. All costs incurred in first year.

(H)Cap unpaved areas with 3 feet of non-engineered fill.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	mobilization/demobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	1,940	9,700
(3)	Soil Washing Equipment Rental	month	10,000	10	100,000
(4)	Soil Washing Costs				
	(solvent and manpower)	yd^3	130	1,940	252,200
(5)	Confirmation samples	ea.	500	10	5,000
(6)	Decommission Groundwater Monitoring Wells	well	1,500	4	6,000
(7)	Cap with 3 feet of fill	yd^3	4	68,600	274,400
			Subtotal		\$652,300
(8)	Health and Safety at 10%			0.1	65,230
(9)	Engineering and Supervision at 30%			0.3	195,690
(10)	Contingency at 20%			0.2	130,460
		TOTAL CAPITAL COST			\$1,043,680

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS \$1,043,680

04/26/94

TABLE D-7.1.9
SITE 7: AIRCRAFT MAINTENANCE - SOILS
ASPHALT CAPPING COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil area = 68,600 yd^2 (cap unpaved areas)
(B) Assumes minor grading required
(C) Assumes existing asphalt is not removed
(D) Assumes 2" thick asphalt
(E) Project life estimated at less than 1 year

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	1,000	1	1,000
(2)	Grade Site	day	1	600	600
(3)	Lay asphalt	yd^2	4.85	68,600	332,710
			Subtotal		$334,310
(7)	Health and Safety at 10%			0.1	33,430
(8)	Engineering and Supervision at 20%			0.2	66,860
(9)	Contingency at 20%			0.2	66,860
		TOTAL CAPITAL COST			$501,460

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $501,460

04/28/94

TABLE D–7.2.1
SITE 7: AIRCRAFT MAINTENANCE – SEDIMENT
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(B) Quarterly groundwater sampling and reporting for 30 years, at 4 samples per event.
(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five–year period.
(D) Project life assumed to be 30 years at 10% annual interest rate.
(E) Land use restrictions are necessary to warn and restrict receptor access.
(F) Operation and maintenance of land use restriction requires 30 years.

NOTE: This cost estimate is identical to Table DW–7.1, Site 7: Aircraft Maintenance, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$14,800
(3)	Planning and regulatory compliance at 30%			0.3	4,440
(4)	Engineering and Supervision at 20%			0.2	2,960
(5)	Contingency at 20%			0.2	2,960
		TOTAL CAPITAL COST			$25,160
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$44,200
(4)	Contingency at 20%			0.2	8,840
		TOTAL ANNUAL O & M COST			$53,040
TOTAL PRESENT WORTH COSTS					$525,200

04/24/94

TABLE D-7.2.2
SITE 7: AIRCRAFT MAINTENANCE – SEDIMENT BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 2,220 yd^3 (soils contaminated with TPH, metals); cover material = 3,330 yd^3.

(B)Application of nutrients and micro-organisms estimated at \$3/yd^3.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 10 samples.

(D)Assume use of an existing pad.

(E)Treated soils will be returned to excavated area.

(F)Tilling once a week for project life period (16 hrs per week).

(G)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Solidification mobilization/demobization	ea.	5,000	1	5,000
(4)	Solidification equipment (year 2)	yd^3	30	2,220	66,600
(5)	Solidification agents (year 2)	yd^3	60	2,220	133,200
(6)	Cap with 3 feet of fill	yd^3	4	3,330	13,320
			Subtotal		\$238,120
(7)	Health and Safety at 10%			0.1	23,810
(8)	Engineering and Supervision at 20%			0.2	47,620
(9)	Contingency at 20%			0.2	47,620
		TOTAL CAPITAL COST			\$357,170
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	2,220	6,660
(2)	Soils Handling (tilling, 16 hr/week)	hrs	60	832	49,920
(3)	Confirmation soil sampling	ea.	500	10	5,000
			Subtotal		\$61,580
(4)	Health and Safety at 10%			0.1	6,160
(5)	Engineering and Supervision at 20%			0.2	12,320
(6)	Contingency at 20%			0.2	12,320
	TOTAL ANNUAL O & M COST (0-2 YEARS)				\$92,380
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM-7 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					\$517,500

04/26/94

TABLE D-7.2.3
SITE 7: AIRCRAFT MAINTENANCE – SEDIMENT
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 2,220 yd^3 (TPH, metals); cover material = 3,330 yd^3.

(B)Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of an existing pad.

(C)Soils handling includes excavation, backfilling, compacting, and site regrade.

(D)Treated soil will be returned to excavated area.

(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 10 samples.

(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 2 units for project.

(G)Project life estimated at 6 months.

(H)Addition of solidification agents assumed at $60/yd^3$.

(I)Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $30/yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				10,000
(2)	Soils Handling	yd^3	25	2,220	55,500
(3)	Thermal Desorption	yd^3	100	2,220	222,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	10	5,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	2	4,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	3	4,500
(8)	Solidification mobilization/demobilization	ea.	5,000	1	5,000
(9)	Solidification equipment	yd^3	30	2,220	66,600
(10)	Solidification agents	yd^3	60	2,220	133,200
(11)	Cap with 3 feet of fill	yd^3	4	3,330	13,320
			Subtotal		$529,120
(12)	Health & Safety/ Air Monitoring at 10%			0.1	52,910
(13)	Engineering and Supervision at 30%			0.3	158,740
(14)	Contingency at 20%			0.2	105,820
		TOTAL CAPITAL COST			$846,590

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $846,590

04/26/94

TABLE D-7.2.4
SITE 7: AIRCRAFT MAINTENANCE - SEDIMENT
OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 10 yd^3 at 1.25 tons/yd^3 (TPH, SVOCs, metals).
(B) Soil will be transported to Rollins Facility in Deer Park, Texas.
(C) Incineration costs assumed to be $0.60/lb ($1,200/ton)
(D) Transportation cost assumed to be $250/ton
(E) Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.
(F) No annual costs for this alternative. All costs incurred in first year.
(G) Project life estimated at 6 months.
(H) Addition of solidification agents assumed at $60/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation (mobilization)	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	10	50
(3)	Transport to Off-site Facility	ton	250	13	3,250
(4)	Off-site Incineration	ton	1,200	13	15,600
(5)	Confirmation soil sampling	ea.	500	4	2,000
(6)	Solidification mobilization/demobilization	ea.	5,000	1	5,000
(7)	Solidification equipment	yd^3	30	10	300
(8)	Solidification agents	yd^3	60	10	600
(9)	Seal Storm Drains and Outlet	job	6,000	1	6,000
			Subtotal		$37,800
(10)	Engineering and Supervision at 10%			0.1	3,780
(11)	Contingency at 10%			0.1	3,780
		TOTAL CAPITAL COST			$45,360

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-7 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS	$45,360

05/02/94

TABLE D-8.1
SITE 8: FUEL LINES
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 1 monitoring well at $4,000.

(B)Sampling of the well for petroleum hydrocarbons, volatile and semi-volatile organic compounds.

(C)Quarterly groundwater sampling and reporting only for the well after first year.

(D)Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(E)Project life assumed to be 30 years at 10% annual interest rate.

(F)Land use restrictions are necessary to warn and restrict receptor access.

(G)Operation and maintenance of land use restriction requires 30 years.

Note:This cost estimate is identical to Table DW-8.1, Site 8: Fuel Lines, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	1	4,000
(2)	Sample collection and analyses	event	9,200	1	9,200
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$18,200
(4)	Planning and regulatory compliance at 30%			0.3	5,460
(5)	Engineering and Supervision at 20%			0.2	3,640
(6)	Contingency at 20%			0.2	3,640
	TOTAL CAPITAL COST				$30,940
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,200	4	36,800
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$41,800
(4)	Contingency at 20%			0.2	8,360
	TOTAL ANNUAL O & M COST				$50,160
TOTAL PRESENT WORTH COSTS					$503,800

04/24/94

TABLE D–8.2
SITE 8: FUEL LINES
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 3,190 yd^3.
(B)Application of nutrients and micro–organisms estimated at \$3/yd^3.
(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 6 samples.
(D)Treated soils will be returned to excavated area.
(E)Tilling once a week for project life period (8 hrs per week).
(F)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Soil Excavation	yd^3	5	3,190	15,950
(4)	Backfill excavation site (at end of project)	yd^3	4	3,190	12,760
			Subtotal		\$48,710
(5)	Health and Safety at 10%			0.1	4,871
(6)	Engineering and Supervision at 20%			0.2	9,742
(7)	Contingency at 20%			0.2	9,742
			TOTAL CAPITAL COST		\$73,000
ANNUAL OPERATIONS AND MAINTENANCE (0–2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	3,190	9,570
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	416	24,960
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		\$37,530
(4)	Health and Safety Air Monitoring at 10%			0.1	3,750
(5)	Engineering and Supervision at 20%			0.2	7,510
(6)	Contingency at 20%			0.2	7,510
	TOTAL ANNUAL O & M COST (0–2 YEARS)				\$56,300
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					
	NOTE: Refer to Table DWM–8 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					\$170,710

04/24/94

TABLE D-8.3
SITE 8: FUEL LINES
LOW TEMPERATURE THERMAL DESORPTION
COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 3,190 yd^3.

(B)Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed.

(C)Soils handling includes excavation, backfilling, compacting, and site regrade.

(D)Treated soil will be returned to excavated area.

(E)Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 6 samples.

(F)Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $6,000 per unit. Assume 8 units for project.

(G)Project life estimated at 6 months.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	50	3,190	159,500
(3)	Thermal Desorption	yd^3	100	3,190	319,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	6	3,000
(6)	GAC Units(regeneration, transportation)	ea.	6,000	8	48,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	6,000	3	18,000
			Subtotal		$565,500
(8)	Health & Safety/ Air Monitoring at 10%			0.1	56,550
(9)	Engineering and Supervision at 30%			0.3	169,650
(10)	Contingency at 20%			0.2	113,100
		TOTAL CAPITAL COST			$904,800

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)

NOTE: Refer to Table D-8.1 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $904,800

04/24/94

TABLE D–9.1
SITE 9: BUILDING 442 AST
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)No remedial activities.
(B)Soil remains in current condition.
(C)No land use restrictions necessary.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	No remedial activites.				
		TOTAL CAPITAL COST			$0
ANNUAL OPERATIONS AND MAINTENANCE COST					
(1)	No remedial activites.				
		TOTAL ANNUAL O & M COST			$0
TOTAL PRESENT WORTH COSTS					$0

04/24/94

TABLE D-10
CENTRALIZED TREATMENT SITES 2 THROUGH 8: TPH EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 76,000 yd^3, based on the total volume of TPH >10 mg/kg at sites 2, 3, 4 (AST-5 and stockpile), and 8.

(B)Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C)Confirmation soil samples will be taken to monitor biodegradation. Assume 270 samples.

(D)Tilling project life period (60 hrs per week).

(E)Project life estimated at 2 years.

(F)Assume centralized treatment of Revetment Area

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	120,000	1	120,000
(3)	Transport to Central Facility	ea.	30,000	1	30,000
(4)	Soil Excavation	yd^3	5	76,000	380,000
(5)	Decommission groundwater monitoring wells	wells	1,500	4	6,000
(6)	Backfill excavation site (at end of project)	yd^3	4	76,000	304,000
			Subtotal		$845,000
(7)	Health and Safety at 10%			0.1	84,500
(8)	Engineering and Supervision at 20%			0.2	169,000
(9)	Contingency at 20%			0.2	169,000
		TOTAL CAPITAL COST			$1,268,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	76,000	228,000
(2)	Soils Handling (tilling, etc., 50 hr/wk)	hrs	60	2,500	150,000
(3)	Confirmation soil sampling	ea.	500	270	135,000
			Subtotal		$513,000
(4)	Health and Safety at 10%			0.1	51,300
(5)	Engineering and Supervision at 20%			0.2	102,600
(6)	Contingency at 20%			0.2	102,600
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$769,500
TOTAL PRESENT WORTH COSTS					$2,603,500

05/06/94

TABLE D-11
CENTRALIZED TREATMENT SITES 2 THROUGH 8: TPH AND METALS EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 2,240 yd^3, based on the total volume of soil contaminated with both TPH and metals (sites 4 (AST-7) and 7).
Capping volume = 68,600 yd^3 at site 7

(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C) Confirmation soil samples will be taken to monitor biodegration. Assume 25 samples.

(D) Assume the use of an existing Pad.

(E) Tilling once a week for project life period (20 hrs per week).

(F) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Soil Excavation	yd^3	5	2,240	11,200
(4)	Transport to Central Facility	ea.	4,000	1	4,000
(5)	Solidification Mobilization/Demobilization	ea.	5,000	1	5,000
(6)	Solidification equipment (year 2)	yd^3	30	2,240	67,200
(7)	Solidification agents (year 2)	yd^3	60	2,240	134,400
(8)	Land disposal of treated soil (year 2)	yd^3	4	2,240	8,960
(9)	Decommission groundwater monitoring wells	wells	1500	3	4,500
(10)	Capping with three feet of soil	yd^3	4	68,600	274,400
			Subtotal		$529,660
(11)	Health and Safety at 10%			0.1	52,966
(12)	Engineering and Supervision at 20%			0.2	105,932
(13)	Contingency at 20%			0.2	105,932
			TOTAL CAPITAL COST		$794,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	2,240	6,720
(2)	Soils Handling (tilling, etc., 20 hr/wk)	hrs	60	1040	62,400
(3)	Confirmation soil sampling	ea.	500	25	12,500
			Subtotal		$81,620
(4)	Health and Safety at 10%			0.1	8,160
(5)	Engineering and Supervision at 20%			0.2	16,320
(6)	Contingency at 20%			0.2	16,320
			TOTAL ANNUAL O & M COST (0-2 YEARS)		$122,420
TOTAL PRESENT WORTH COSTS					$1,006,460

04/28/94

TABLE DW-1.1
SITE 1: POL AREA
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling the 15 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(B) Quarterly groundwater sampling and reporting only for 8 wells after first year.
(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(D) Project life assumed to be 30 years at 10% annual interest rate.
(E) Land use restrictions are necessary to warn and restrict receptor access.
(F) Operation and maintenance of land use restriction requires 30 years.

NOTE: This cost estimate is identical to Table D-1.1, Site 1: POL Area, No Action Cost Estimate, Soil.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	12,000	1	12,000
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
(3)	Planning and regulatory compliance at 30%			0.3	3,600
(4)	Engineering and Supervision at 20%			0.2	2,400
(5)	Contingency at 20%			0.2	2,400
		TOTAL CAPITAL COST			$25,400
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	10,600	4	42,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr.	1,000	1	1,000
			Subtotal		$47,400
(4)	Contingency at 20%			0.2	9,480
		TOTAL ANNUAL O & M COST			$56,880
TOTAL PRESENT WORTH COSTS					$561,600

TABLE DW-1.2
SITE 1: POL AREA
BIOSTIMULATION COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 3 additional monitoring wells (at $4000 each).
(B) Installation of 4 injection wells (at $6000 each) within area of groundwater contamination.
(C) Hydrogen peroxide and nutrient application costs estimated to be $5/pound of contaminant. Assume 12,000 lbs. of contaminant based on maximum (503 mg/kg) TPH concentration. All nutrients in capital costs.
(D) Quarterly groundwater sampling and reporting for 15 wells after first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	3	12,000
(2)	Sampling and analysis	event	9,600	1	9,600
(3)	Installation of injection wells	ea.	6,000	4	24,000
	Hydrogen peroxide and nutrient addition	lb.	5	12,000	60,000
			Subtotal		$105,600
(4)	Health and Safety at 10%			0.1	10,560
(5)	Engineering and Supervision at 30%			0.3	31,680
(6)	Contingency at 20%			0.2	21,120
	TOTAL CAPITAL COST				$168,960
ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)					$55,880
	Refer to Table DWM-1 for groundwater monitoring costs, (20 years).				
	Additional quarterly sampling for new wells (summary report costs included already in Table DWM-1).	event	1,500	4	6,000
TOTAL PRESENT WORTH COSTS					$695,800

TABLE DW-1.3
SITE 1: POL AREA
CARBON ADSORPTION COST ESTIMATE

ASSUMPTIONS:

- (A) Install 6 extraction wells at cost of $15,000 each.
- (B) Install air compressor pumps at $5,000.
- (C) Construct on-site GAC treatment unit for 20 gal/day average flow. Treatment unit costs include mobilization, equipment, connections, 2 carbon units (50 lbs ea.), filters, piping, electrical and demobilization.
- (D) Annual O&M costs include regenerating 2 carbon units per year, effluent monitoring and POTW fees at $2500/month.
- (E) Remediation project life = 20 years
- (F) Groundwater monitoring required for 20 years, at 15 samples per quarterly event.
- (G) The treated solution will be discharged to San Pablo Bay under NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Installation of extraction wells	well	15,000	4	60,000
(2)	Installation of air compressor	ea.	5,000	1	5,000
(3)	Construct GAC treatment unit	ea.	20,000	1	20,000
			Subtotal		$85,000
(4)	Health and Safety at 10%			0.1	8,500
(5)	Engineering and Supervision at 20%			0.2	17,000
(6)	Contingency at 20%			0.2	17,000
		TOTAL CAPITAL COST			$127,500

ANNUAL OPERATIONS AND MAINTENANCE, GAC (20 YEARS)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	GAC operations				
	GAC regeneration	ea.	700	1	700
	effluent monitoring and discharge fees	yr	5,000	1	5,000
			Subtotal		$5,700
(2)	Health and Safety at 10%			0.1	570
(3)	Engineering and Supervision at 20%			0.2	1,140
(4)	Contingency at 20%			0.2	1,140
	TOTAL ANNUAL O & M COST (20 YEARS)				$8,550

ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS) $55,880

Refer to Table DWM-1 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS $676,030

TABLE DW-1.4
SITE 1: POL AREA
BIOLOGICAL TREATMENT COST ESTIMATE

ASSUMPTIONS:

(A) Install 6 extraction wells at cost of $15,000 each.
(B) Install air compressor for pumps at $5,000.
(C) Construct on-site biologoical treatment unit for 20 gal/day average flow (3,000,000 gal/yr). Treatment unit costs include holding tanks and contactors for addition of nutrients and oxygen.
(D) Annual O&M costs include nutrients and oxygen based on gallons needed.
(E) Remediation project life = 20 years
(F) Groundwater monitoring required for 20 years, at 15 samples per quarterly event.
(G) The treated solution will be discharged to San Pablo Bay under NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Installation of extraction wells	ea.	15,000	4	60,000
(2)	Installation of air compressor	ea.	5,000	1	5,000
(3)	Construct above ground biological treatment unit	ea.	20,000	1	20,000
			Subtotal		$85,000
(4)	Health and Safety at 10%			0.1	8,500
(5)	Engineering and Supervision at 20%			0.2	17,000
(6)	Contingency at 20%			0.2	17,000
	TOTAL CAPITAL COST				$127,500
	ANNUAL OPERATIONS AND MAINTENANCE, TREATMENT UNIT (20 YEARS)				
(1)	Treatment unit operations	1000 gal	1	3,000,000	3,000
	effluent monitoring and discharge fees	yr	5,000	1	5,000
			Subtotal		$8,000
(2)	Health and Safety at 10%			0.1	800
(3)	Engineering and Supervision at 20%			0.2	1,600
(4)	Contingency at 20%			0.2	1,600
	TOTAL ANNUAL O & M COST (20 YEARS)				$12,000
	ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)				$56,880
	Refer to Table DWM-1 for groundwater monitoring costs.				
	TOTAL PRESENT WORTH COSTS				$713,910

TABLE DW-2.1
SITE 2: BURN PIT
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatiie and semivolatile organic compounds.

(B) Quarterly sampling of 4 wells and summary report.

(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D) Project life assumed to be 30 years at 10% annual interest rate.

NOTE: This cost estimate is identical to Table D-2.1.1, Site 2:Burn Pit - Beneath Pad, No Action Cost Estimate, Soil, and to Table D-2.2.1, Site 2:Burn Pit - Perimeter, No Action Cost Estimate, Soil.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Planning and regulatory compliance at 30%			0.3	2,940
(3)	Engineering and Supervision at 20%			0.2	1,960
(4)	Contingency at 20%			0.2	1,960
			TOTAL CAPITAL COST		$16,660
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs. Cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$43,200
(3)	Contingency at 20%			0.2	8,640
			TOTAL ANNUAL O & M COST		$51,800
TOTAL PRESENT WORTH COSTS					$504,970

TABLE DW-3.1
SITE 3: REVETMENT AREA
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling the 3 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B) Quarterly groundwater sampling and reporting for 3 wells.

(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D) Project life assumed to be 30 years at 10% annual interest rate.

NOTE: This cost estimate is identical to Table D-3.1, Site 3: Revetment Area, No Action Cost Estimate, Soil.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,600	1	9,600
(2)	Planning and regulatory compliance at 30%			0.3	2,880
(3)	Engineering and Supervision at 20%			0.2	1,920
(4)	Contingency at 20%			0.2	1,920
		TOTAL CAPITAL COST			$16,320
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$42,400
(3)	Contingency at 20%			0.2	8,480
		TOTAL ANNUAL O & M COST			$50,880
TOTAL PRESENT WORTH COSTS					$496,000

TABLE DW-4.1
SITE 4: PUMP STATION AREA
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 2 additional monitoring wells at $4,000 each.

(B) Sampling of the 1 existing well and 2 new wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(C) Quarterly groundwater sampling and reporting only for 3 wells after first year.

(D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(E) Project life assumed to be 30 years at 10% annual interest rate.

(F) Land use restrictions are necessary to warn and restrict receptor access.

(G) Operation and maintenance of land use restriction requires 20 years.

NOTE: This cost estimate is identical to Table D-4.1.1, Site 4: Pump Station Area - AST Sites, No Action, Soil.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	9,600	1	9,600
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$22,600
(4)	Planning and regulatory compliance at 30%			0.3	6,780
(5)	Engineering and Supervision at 20%			0.2	4,520
(6)	Contingency at 20%			0.2	4,520
	TOTAL CAPITAL COST				$38,420
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$43,400
(4)	Contingency at 20%			0.2	8,680
	TOTAL ANNUAL O & M COST				$52,080
TOTAL PRESENT WORTH COSTS					$529,400

TABLE DW-5.1
SITE 5: FORMER SEWAGE TREATMENT PLANT
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 2 additional monitoring wells at $4,000 each.

(B) Sampling of the 1 existing well, 2 new wells and pond for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(C) Quarterly groundwater sampling and reporting only for 3 wells after first year.

(D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(E) Project life assumed to be 30 years at 10% annual interest rate.

(F) Land use restrictions are necessary to warn and restrict receptor access.

(G) Operation and maintenance of land use restriction requires 30 years.

NOTE: This cost estimate is identical to Table D-5.1, Site 5: Former Sewage Treatment Plant, No Action, Groundwater.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	10,000	1	10,000
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$23,000
(4)	Planning and regulatory compliance at 30%			0.3	6,900
(5)	Engineering and Supervision at 20%			0.2	4,600
(6)	Contingency at 20%			0.2	4,600
	TOTAL CAPITAL COST				$39,100
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	10,000	4	40,000
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$45,000
(4)	Contingency at 20%			0.2	9,000
	TOTAL ANNUAL O & M COST				$54,000
TOTAL PRESENT WORTH COSTS					$548,200

TABLE DW-5.2
SITE 5: FORMER SEWAGE TREATMENT PLANT
CARBON ADSORPTION COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 250 linear foot collection trench at cost of $40/ft.
(B) Install 2 pumps at cost of $3,000/each.
(C) Construct on-site GAC treatment unit for 5 gpm average flow. Treatment unit costs include mobilization, equipment, connections, 2 carbon units (200 lbs ea.), filters, piping, electrical and demobilization.
(D) Annual O&M costs include regenerating 2 carbon units per year, effluent monitoring and POTW fees at $2500/month.
(E) Remediation project life = 20 years
(F) Groundwater monitoring required for 20 years, at 3 samples per quarterly event.
(G) The created solution will be discharged to San Pablo Bay under NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Installation of collection trench	feet	40	250	10,000
(2)	Pumps	pump	800	2	1,600
(3)	Construct GAC treatment unit	ea.	20,000	1	20,000
			Subtotal		$31,600
(4)	Health and Safety at 10%			0.1	3,160
(5)	Engineering and Supervision at 30%			0.3	9,480
(6)	Contingency at 20%			0.2	6,320
	TOTAL CAPITAL COST				$50,560
	ANNUAL OPERATIONS AND MAINTENANCE, GAC (20 YEARS)				
(1)	GAC operations				
	GAC regeneration	ea.	1,000	2	2,000
	effluent monitoring and discharge fees	yr.	5,000	1	5,000
			Subtotal		$7,000
(2)	Health and Safety at 10%			0.1	700
(3)	Engineering and Supervision at 30%			0.3	2,100
(4)	Contingency at 20%			0.2	1,400
	TOTAL ANNUAL O & M COST (20 YEARS)				$11,200
	ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)				
	Refer to Table DWM-5 for surface and groundwater monitoring costs.				$54,000
	TOTAL PRESENT WORTH COSTS				$605,640

TABLE DW-6.1
SITE 6: EAST LEVEE LANDFILL
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling the 5 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B) Quarterly groundwater sampling and reporting only for 5 wells after first year.

(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D) Project life assumed to be 30 years at 10% annual interest rate.

NOTE: This cost estimate is identical to Table D-6.1, Site 6: East Levee Landfill, No Action, Soil.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	10,000	1	10,000
(2)	Planning and regulatory compliance at 30%			0.3	3,000
(3)	Engineering and Supervision at 20%			0.2	2,000
(4)	Contingency at 20%			0.2	2,000
		TOTAL CAPITAL COST			$17,000
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	10,000	4	40,000
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$44,000
(3)	Contingency at 20%			0.2	8,800
		TOTAL ANNUAL O & M COST			$52,800
TOTAL PRESENT WORTH COSTS					$514,700

TABLE DW-7.1
SITE 7: AIRCRAFT MAINTENANCE
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(B) Quarterly groundwater sampling and reporting only for four wells after first year.
(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(D) Project life assumed to be 30 years at 10% annual interest rate.
(E) Land use restrictions are necessary to warn and restrict receptor access.
(F) Operation and maintenance of land use restriction requires 30 years.

NOTE: This cost estimate is identical to Table D-7.1, Site 7: Aircraft Maintenance Soil, No Action, Soil.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$14,800
(3)	Planning and regulatory compliance at 30%			0.3	4,440
(4)	Engineering and Supervision at 20%			0.2	2,960
(5)	Contingency at 20%			0.2	2,960
		TOTAL CAPITAL COST			$25,160
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$44,200
(4)	Contingency at 20%			0.2	8,840
		TOTAL ANNUAL O & M COST			$53,040
TOTAL PRESENT WORTH COSTS					$525,200

TABLE DW-7.2
SITE 7: AIRCRAFT MAINTENANCE
CARBON ADSORPTION COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 4 extraction well at $10,000 each.

(B)Install air compression for pumps at $5,000.

(C)Construct on-site GAC treatment unit for 0.1 gpm average flow (40 gal/day each well). Treatment unit costs include mobilization, connections, 2 carbon units (50 lbs ea.), precipitation/filter equipment, piping, electrical and demobilization.

(D)Annual O&M costs include regenerating 2 carbon units per year.

(E)Remediation project life = 20 years

(F)Groundwater monitoring required for 20 years, at 8 samples per quarterly event.

(G)The treated solution will be discharged to San Pablo Bay under NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Installation of interceptor trench	ea.	40,000	1	40,000
(2)	Installation of air comperssor	ea.	5,000	1	5,000
(3)	Construct GAC treatment unit	ea.	25,000	1	25,000
			Subtotal		$70,000
(4)	Health and Safety at 10%			0.1	7,000
(5)	Engineering and Supervision at 30%			0.3	21,000
(6)	Contingency at 20%			0.2	14,000
		TOTAL CAPITAL COST			$112,000
ANNUAL OPERATIONS AND MAINTENANCE, GAC (20 YEARS)					
(1)	GAC operations				
	GAC regeneration	ea.	700	1	700
	effluent monitoring and discharge fees	yr	5,000	1	5,000
			Subtotal		$5,700
(2)	Health and Safety at 10%			0.1	570
(3)	Engineering and Supervision at 30%			0.3	1,710
(4)	Contingency at 20%			0.2	1,140
	TOTAL ANNUAL O & M COST (20 YEARS)				$9,120
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					$53,040
	Refer to Table DWM-7 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$641,200

05/05/94

TABLE DW–7.3
SITE 7: AIRCRAFT MAINTENANCE
BIOLOGICAL TREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 4 extraction well at $10,000 each.

(B)Install air compressor for pumps at $5,000.

(C)Construct on–site biologoical treatment unit for 0.1 gpm average flow (40 day/day each well). Treatment unit costs include holding tanks, precipitators, filters and contactors for addition of nutrients and oxygen.

(D)Annual O&M costs include nutrients.
Remediation project life = 20 years

(E)Groundwater monitoring required for 20 years, at 8 samples per quarterly event.

(F)The treated solution will be released to San Pablo Bay under NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Construction of interceptor trench	ea.	40,000	1	40,000
(2)	Installation of air compressor	ea.	5,000	1	5,000
(3)	Construct above ground biological treatment unit	ea.	30,000	1	30,000
			Subtotal		$75,000
(4)	Health and Safety at 10%			0.1	7,500
(5)	Engineering and Supervision at 30%			0.3	22,500
(6)	Contingency at 20%			0.2	15,000
		TOTAL CAPITAL COST			$120,000
ANNUAL OPERATIONS AND MAINTENANCE, TREATMENT UNIT (20 YEARS)					
(1)	Treatment unit operations and monitoring				
	nutrients and oxygen based on gallons treated	1000 gal.	1	58,000	100
	effluent monitoring and discharge fees	yr	5,000	1	5,000
			Subtotal		$5,100
(2)	Health and Safety at 10%			0.1	510
(3)	Engineering and Supervision at 30%			0.3	1,530
(4)	Contingency at 20%			0.2	1,020
	TOTAL ANNUAL O & M COST (20 YEARS)				$8,160
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					$53,040
	Refer to Table DWM–7.1 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$641,030

05/05/94

TABLE DW–7.4
SITE 7: AIRCRAFT MAINTENANCE
UV/OZONE COST ESTIMATE

ASSUMPTIONS:

(A)Installation of 4 extraction wells at $10,000 each.

(B)Install air compressor for pumps at $5,000.

(C)Construct on–site UV/ozone treatment unit for 0.1 gpm average flow (40 gal/day each well). Treatment unit costs include precipitator, filter, UV reactor, ozone chamber.

(D)Annual O&M costs include hydrogen peroxide, UV lamps, power, and miscellaneous equipment at $8,000/yr.
Remediation project life = 20 years

(E)Groundwater monitoring required for 20 years, at 8 samples per quarterly event.

(F)The treated solution will be discharged to San Pablo Bay under NPDES permit.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
(1)	Construction of interceptor trench	ea.	40,000	1	40,000
(2)	Installation of air compressor	ea.	5,000	1	5,000
(3)	Construct UV/ozone treatment unit	ea.	110,000	1	110,000
			Subtotal		$155,000
(4)	Health and Safety at 10%			0.1	15,500
(5)	Engineering and Supervision at 30%			0.3	46,500
(6)	Contingency at 20%			0.2	31,000
		TOTAL CAPITAL COST			$248,000
ANNUAL OPERATIONS AND MAINTENANCE, TREATMENT UNIT (20 YEARS)					
(1)	Treatment unit operations and monitoring				
	hydrogen peroxide, UV lamps, power	yr	8,000	1	8,000
	effluent monitoring and discharge fees	yr	5,000	1	5,000
			Subtotal		$13,000
(2)	Health and Safety at 10%			0.1	1,300
(3)	Engineering and Supervision at 30%			0.3	3,900
(4)	Contingency at 20%			0.2	2,600
		TOTAL ANNUAL O & M COST (20 YEARS)			$20,800
ANNUAL OPERATIONS AND MAINTENANCE, MONITORING (20 YEARS)					$53,040
	Refer to Table DWM–7 for groundwater monitoring costs.				
TOTAL PRESENT WORTH COSTS					$876,640

05/05/94

TABLE DW-8.1
SITE 8: FUEL LINES
NO ACTION COST ESTIMATE

ASSUMPTIONS:

- (A) Installation of 1 monitoring well at $4,000.
- (B) Sampling of the well for petroleum hydrocarbons. volatile and semivolatine organic compounds.
- (C) Quarterly groundwater sampling and reporting only for the well after first year.
- (D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
- (E) Project life assumed to be 30 years at 10% annual interest rate.
- (F) Land use restrictions are necessary to warn and restrict receptor access.
- (G) Operation and maintenance of land use restriction requires 30 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	1	4,000
(2)	Sample collection and analyses	event	9,200	1	9,200
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$18,200
(4)	Planning and regulatory compliance at 30%			0.3	5,460
(5)	Engineering and Supervision at 20%			0.2	3,640
(6)	Contingency at 20%			0.2	3,640
			TOTAL CAPITAL COST		$30,940
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
(1)	Quarterly sampling and summary report	event	9,200	4	36,800
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$41,800
(4)	Contingency at 20%			0.2	8,360
			TOTAL ANNUAL O & M COST		$50,160
TOTAL PRESENT WORTH COSTS					$503,800

TABLE DWM-1
SITE 1: POL AREA
MONITORING COST ESTIMATE

ASSUMPTIONS:

- (A) Sampling the 15 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
- (B) Quarterly groundwater sampling and reporting only for 8 wells after first year.
- (C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
- (D) Project life assumed to be 20 years at 10% annual interest rate.
- (E) Land use restrictions are necessary to warn and restrict receptor access.
- (F) Operation and maintenabce of land use restriction requires 20 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	12,000	1	12,000
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
(3)	Planning and regulatory compliance at 30%			0.3	3,600
(4)	Engineering and Supervision at 20%			0.2	2,400
(5)	Contingency at 20%			0.2	2,400
			TOTAL CAPITAL COST		$25,400
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	10,600	4	42,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr.	1,000	1	1,000
			Subtotal		$47,400
(4)	Contingency at 20%			0.2	9,480
			TOTAL ANNUAL O & M COST		$56,880
TOTAL PRESENT WORTH COSTS					$509,700

TABLE DWM-2
SITE 2: BURN PIT
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B) Quarterly sampling of 4 wells and summary report.

(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D) Project life assumed to be 20 years at 10% annual interest rate.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Planning and regulatory compliance at 30%			0.3	2,940
(3)	Engineering and Supervision at 20%			0.2	1,960
(4)	Contingency at 20%			0.2	1,960
	TOTAL CAPITAL COST				$16,660
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs. Cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$43,200
(3)	Contingency at 20%			0.2	8,640
	TOTAL ANNUAL O & M COST				$51,800
TOTAL PRESENT WORTH COSTS					$457,660

TABLE DWM-3
SITE 3: REVETMENT AREA
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Sampling the 3 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(B) Quarterly groundwater sampling and reporting for 3 wells.

(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(D) Project life assumed to be 20 years at 10% annual interest rate.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,600	1	9,600
(2)	Planning and regulatory compliance at 30%			0.3	2,880
(3)	Engineering and Supervision at 20%			0.2	1,920
(4)	Contingency at 20%			0.2	1,920
	TOTAL CAPITAL COST				$16,320
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr.	20,000	0.2	4,000
			Subtotal		$42,400
(3)	Contingency at 20%			0.2	8,480
	TOTAL ANNUAL O & M COST				$50,880
TOTAL PRESENT WORTH COSTS					$449,500

TABLE DWM-4
SITE 4: PUMP STATION AREA
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 2 additional monitoring wells at $4,000 each.

(B) Sampling of the 1 existing well and 2 new wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.

(C) Quarterly groundwater sampling and reporting only for 3 wells after first year.

(D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.

(E) Project life assumed to be 20 years at 10% annual interest rate.

(F) Land use restrictions are necessary to warn and restrict receptor access.

(G) Operation and maintenance of land use restriction requires 20 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	9,600	1	9,600
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$22,600
(4)	Planning and regulatory compliance at 30%			0.3	6,780
(5)	Engineering and Supervision at 20%			0.2	4,520
(6)	Contingency at 20%			0.2	4,520
		TOTAL CAPITAL COST			$38,420
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	9,600	4	38,400
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$43,400
(4)	Contingency at 20%			0.2	8,680
		TOTAL ANNUAL O & M COST			$52,080
TOTAL PRESENT WORTH COSTS					$481,800

TABLE DWM-5a
SITE 5: FORMER SEWAGE TREATMENT PLANT
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Installation of 2 additional monitoring wells at $4,000 each.
(B) Sampling of the 1 existing well, 2 existing wells and pond for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(C) Quarterly groundwater sampling and reporting only for three wells after first year.
(D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(E) Project life assumed to be 20 years at 10% annual interest rate.
(F) Land use restrictions are necessary to warn and restrict receptor access.
(G) Operation and maintenance of land use restriction requires 20 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring wells	well	4,000	2	8,000
(2)	Sample collection and analyses	event	10,000	1	10,000
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$23,000
(4)	Planning and regulatory compliance at 30%			0.3	6,900
(5)	Engineering and Supervision at 20%			0.2	4,600
(6)	Contingency at 20%			0.2	4,600
			TOTAL CAPITAL COST		$39,100
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	10,000	4	40,000
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$45,000
(4)	Contingency at 20%			0.2	9,000
			TOTAL ANNUAL O & M COST		$54,000
TOTAL PRESENT WORTH COSTS					$498,800

TABLE DWM-5b
SITE 5: FORMER SEWAGE TREATMENT PLANT
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 1 existing well

(B) Quarterly groundwater sampling and reporting only for one year.

(C) All costs are first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Install groundwater monitoring wells	well	1,000	3	3,000
(2)	Sample collection and analyses	event	10,000	1	10,000
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
(4)	Decomission groundwater monitoring wells	well	1,500	4	6,000
			Subtotal		$24,000
(5)	Planning and regulatory compliance at 30%			0.3	7,200
(6)	Engineering and Supervision at 20%			0.2	4,800
(7)	Contingency at 20%			0.2	4,800
		TOTAL CAPITAL COST			$40,800

TOTAL PRESENT WORTH COSTS $40,800

TABLE DWM-5c
SITE 5: FORMER SEWAGE TREATMENT PLANT
MONITORING COST ESTIMATE

ASSUMPTIONS:
- (A) Sampling of the 1 existing well
- (B) Quarterly groundwater sampling and reporting only for one year.
- (C) All costs are first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Install groundwater monitoring wells	well	1,000	3	3,000
(2)	Sample collection and analyses	event	10,000	1	10,000
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$18,000
(4)	Planning and regulatory compliance at 30%			0.3	5,400
(5)	Engineering and Supervision at 20%			0.2	3,600
(6)	Contingency at 20%			0.2	3,600
			TOTAL CAPITAL COST		$30,600
TOTAL PRESENT WORTH COSTS					$30,600

TABLE DWM-6
SITE 6: EAST LEVEE LANDFILL
MONITORING COST ESTIMATE

ASSUMPTIONS:

- (A) Sampling the 5 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
- (B) Quarterly groundwater sampling and reporting only for 5 wells after first year.
- (C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
- (D) Project life assumed to be 20 years at 10% annual interest rate.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	10,000	1	10,000
(2)	Planning and regulatory compliance at 30%			0.3	3,000
(3)	Engineering and Supervision at 20%			0.2	2,000
(4)	Contingency at 20%			0.2	2,000
			TOTAL CAPITAL COST		$17,000
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	10,000	4	40,000
(2)	Risk Assessment	yr.	20,000	0.2	4,000
	(One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)		Subtotal		$44,000
(3)	Contingency at 20%			0.2	8,800
			TOTAL ANNUAL O & M COST		$52,800
TOTAL PRESENT WORTH COSTS					$466,500

TABLE DWM-7
SITE 7: AIRCRAFT MAINTENANCE
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Sampling of the 4 existing wells for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(B) Quarterly groundwater sampling and reporting only for four wells after first year.
(C) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(D) Project life assumed to be 20 years at 10% annual interest rate.
(E) Land use restrictions are necessary to warn and restrict receptor access.
(F) Operation and maintenance of land use restriction requires 20 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Sample collection and analyses	event	9,800	1	9,800
(2)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$14,800
(3)	Planning and regulatory compliance at 30%			0.3	4,440
(4)	Engineering and Supervision at 20%			0.2	2,960
(5)	Contingency at 20%			0.2	2,960
		TOTAL CAPITAL COST			$25,160
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	9,800	4	39,200
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$44,200
(4)	Contingency at 20%			0.2	8,840
		TOTAL ANNUAL O & M COST			$53,040
TOTAL PRESENT WORTH COSTS					$476,700

TABLE DWM-8
SITE 8: FUEL LINES
MONITORING COST ESTIMATE

ASSUMPTIONS:

(A) Installation of a monitoring well at $4,000.
(B) Sampling of the well for petroleum hydrocarbons, volatile and semivolatile organic compounds.
(C) Quarterly groundwater sampling and reporting only for the well after first year.
(D) Risk assessment conducted every five years. Assumed assessment cost of $20,000 is spread out over a five-year period.
(E) Project life assumed to be 20 years at 10% annual interest rate.
(F) Land use restrictions are necessary to warn and restrict receptor access.
(G) Operation and maintenance of land use restriction requires 20 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Installation of monitoring well	well	4,000	1	4,000
(2)	Sample collection and analyses	event	3,000	1	3,000
(3)	Land use restrictions (signs, fencing)	ea.	5,000	1	5,000
			Subtotal		$12,000
(4)	Planning and regulatory compliance at 30%			0.3	3,600
(5)	Engineering and Supervision at 20%			0.2	2,400
(6)	Contingency at 20%			0.2	2,400
		TOTAL CAPITAL COST			$20,400
ANNUAL OPERATIONS AND MAINTENANCE COST (20 YEARS)					
(1)	Quarterly sampling and summary report	event	3,000	4	12,000
(2)	Risk Assessment (One assessment performed every 5 yrs.; cost is averaged over 5 yr period.)	yr	20,000	0.2	4,000
(3)	Land use restriction maintenance	yr	1,000	1	1,000
			Subtotal		$17,000
(4)	Contingency at 20%			0.2	3,400
		TOTAL ANNUAL O & M COST			$20,400
TOTAL PRESENT WORTH COSTS					$194,100

TABLE DF-2.1
SITE 2: BURN PIT – WETLAND OPTION
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)No groundwater quarterly monitoring; no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					$0
		TOTAL CAPITAL COST			$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					$0
		TOTAL ANNUAL O & M COST			$0
TOTAL PRESENT WORTH COSTS					$0

04/24/94

TABLE DF-2.2
SITE 2: BURN PIT - WETLAND OPTION
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 3,390 yd^3; cover material = 1,960 yd^3

(B) Application of nutrients and micro-organisms estimated at \$3/yd^3.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 6 samples.

(D) Assume use of existing Revetment Pad.

(E) Treated soils will be returned to excavated area.

(F) Tilling once a week for project life period (8 hrs per week).

(G) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Remove concrete pad	ea.	20,000	1	20,000
(4)	Soil Excavation	yd^3	5	3,390	16,950
(5)	Land Disposal of Treated Soil	yd^3	4	3,390	13,560
(6)	Apply cover material	yd^3	4	1,960	7,840
			Subtotal		\$78,350
(7)	Health and Safety at 10%			0.1	7,835
(8)	Engineering and Supervision at 20%			0.2	15,670
(9)	Contingency at 20%			0.2	15,670
		TOTAL CAPITAL COST			\$118,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	3,390	10,170
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	416	24,960
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		\$38,130
(4)	Health and Safety at 10%			0.1	3,810
(5)	Engineering and Supervision at 20%			0.2	7,630
(6)	Contingency at 20%			0.2	7,630
	TOTAL ANNUAL O & M COST (0-2 YEARS)				\$57,200
TOTAL PRESENT WORTH COSTS					\$217,270

04/26/94

TABLE DF-2.3
SITE 2: BURN PIT - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 3,390 yd^3; cover material = 1,960 yd^3

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, backfilling, compacting, and site regrade.

(D) Treated soil will be returned to excavated area.

(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 6 samples.

(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 3 units for project.

(G) Air monitoring costs $5,000 per event.

(H) Project life estimated at 4 months.

(I) No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	25	3,390	84,750
(3)	Thermal Desorption	yd^3	100	3,390	339,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation Sampling	sample	500	6	3,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	4	8,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	2	3,000
(8)	Land Disposal of Treated Soil	yd^3	4	3,390	13,560
(9)	Apply cover material	yd^3	4	1,960	7,840
			Subtotal		$477,150
(10)	Health & Safety at 10%			0.1	47,720
(11)	Engineering and Supervision at 20%			0.2	95,430
(12)	Contingency at 20%			0.2	95,430
		TOTAL CAPITAL COST			$715,730

TOTAL PRESENT WORTH COSTS $715,730

04/26/94

TABLE DF-3.1
SITE 3: REVETMENT AND ENGINE TEST PAD AREA - WETLAND OPTION
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) No groundwater monitoring; no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					$0
			TOTAL CAPITAL COST		$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					$0
			TOTAL ANNUAL O & M COST		$0
TOTAL PRESENT WORTH COSTS					$0

04/26/94

TABLE DF-3.2
SITE 3: REVETMENT AND ENGINE TEST PAD AREA - WETLAND OPTION
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 23,500 yd^3; cover material = 77,260 yd^3

(B)Application of nutrients and micro-organisms estimated at \$3/yd^3.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation.

(D)Treated soils will be returned to excavated area.

(E)Tilling project life period (40 hrs per week).

(F)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	100,000	1	100,000
(3)	Soil Excavation	yd^3	5	23,500	117,500
(4)	Land Disposal of Treated Soil	yd^3	4	23,500	94,000
(5)	Apply cover material	yd^3	4	77,260	309,040
			Subtotal		\$625,540
(6)	Health and Safety at 10%			0.1	62,554
(7)	Engineering and Supervision at 20%			0.2	125,108
(8)	Contingency at 20%			0.2	125,108
		TOTAL CAPITAL COST			\$938,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	23,500	70,500
(2)	Soils Handling (tilling, etc., 40 hr/wk)	hrs	60	2100	126,000
(3)	Confirmation soil sampling	ea.	500	110	55,000
			Subtotal		\$251,500
(4)	Health and Safety at 10%			0.1	25,150
(5)	Engineering and Supervision at 20%			0.2	50,300
(6)	Contingency at 20%			0.2	50,300
	TOTAL ANNUAL O & M COST (0-2 YEARS)				\$377,250
TOTAL PRESENT WORTH COSTS					\$1,592,730

05/02/94

TABLE DF-3.3
SITE 3: REVETMENT AND ENGINE TEST PAD AREA - WETLAND OPTION
EXCAVATION AND LOW TEMPERATURE THERMAL DESORPTION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 23,500 yd^3; cover material = 77,260 yd^3.
(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $25,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.
(C) Soils handling includes excavation, backfilling, compacting, and site regrade.
(D) Treated soil will be returned to excavated area.
(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process.
(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit.
(G) Air monitoring costs $5,000 per event.
(H) Project life estimated at 1 year.
(I) No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads	ea.	25,000	1	25,000
(2)	Soils Handling	yd^3	25	23,500	587,500
(3)	Thermal Desorption	yd^3	100	23,500	2,350,000
(4)	Stack Air Monitoring	event	5,000	6	30,000
(5)	Confirmation Sampling	sample	500	110	55,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	36	72,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	18	27,000
(8)	Land Disposal of Treated Soil	yd^3	4	23,500	94,000
(9)	Apply cover material	yd^3	4	77,260	309,040
			Subtotal		$3,549,540
(10)	Health & Safety at 10%			0.1	354,950
(11)	Engineering and Supervision at 20%			0.2	709,910
(12)	Contingency at 20%			0.2	709,910
			TOTAL CAPITAL COST		$5,324,310

TOTAL PRESENT WORTH COSTS $5,324,310

04/26/94

TABLE DF–4.1
SITE 4: PUMP STATION AREA – WETLAND OPTION
NO ACTION COST ESTIMATE

ASSUMPTIONS:
(A)No groundwater monitoring; no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					$0
			TOTAL CAPITAL COST		$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					$0
			TOTAL ANNUAL O & M COST		$0
TOTAL PRESENT WORTH COSTS					$0

04/24/94

TABLE DF-4.2
SITE 4: PUMP STATION AREA - WETLAND OPTION
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

- (A) Contaminated soil volume = 810 yd^3 (AST-5 and stockpile soils contaminated with TPH and PAHs); cover material volume = 650 yd^3.
- (B) Application of nutrients and micro-organisms estimated at \$3/yd^3.
- (C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 8 samples.
- (D) Assume use of existing Revetment Pad.
- (E) Treated soils will be returned to excavated area.
- (F) Tilling once a week for project life period (8 hrs per week).
- (G) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	810	4,050
(4)	Backfill excavation site (at end of project)	yd^3	4	810	3,240
(5)	Apply cover material (year 2)	yd^3	4	650	2,600
			Subtotal		\$24,890
(6)	Health and Safety at 10%			0.1	2,489
(7)	Engineering and Supervision at 20%			0.2	4,978
(8)	Contingency at 20%			0.2	4,978
			TOTAL CAPITAL COST		\$37,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	810	2,430
(2)	Soils Handling (tilling, etc., 8 hr/wk)	hrs	60	416	24,960
(3)	Confirmation soil sampling	ea.	1,000	8	8,000
			Subtotal		\$35,390
(4)	Health and Safety at 10%			0.1	3,540
(5)	Engineering and Supervision at 20%			0.2	7,080
(6)	Contingency at 20%			0.2	7,080
			TOTAL ANNUAL O & M COST (0-2 YEARS)		\$53,090
TOTAL PRESENT WORTH COSTS					\$129,140

04/26/94

TABLE DF-4.3
SITE 4: PUMP STATION AREA - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 810 yd^3 (AST-5 and stockpile soils contaminated with TPH and PAHs); cover material = 650 yd^3.

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, land disposal, applying 3 feet of cover material, compacting, and site regrade.

(D) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 40 sample

(E) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 8 units for project.

(F) Air monitoring costs $5,000 per event.

(G) Project life estimated at 6 months.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads	ea.	8,000	1	8,000
(2)	Soils Handling	yd^3	25	810	20,250
(3)	Thermal Desorption	yd^3	100	810	81,000
(4)	Stack Air Monitoring	event	5,000	8	40,000
(5)	Confirmation soil sampling	sample	1,000	8	8,000
(6)	GAC Units(regeneration, transportation)	ea.	800	8	6,400
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	4	6,000
(8)	Land disposal of treated soil	yd^3	4	810	3,240
(9)	Apply cover material	yd^3	4	650	2,600
			Subtotal		$175,490
(10)	Health & Safety/ Air Monitoring at 10%			0.1	17,550
(11)	Engineering and Supervision at 30%			0.3	52,650
(12)	Contingency at 20%			0.2	35,100
		TOTAL CAPITAL COST			$280,790
TOTAL PRESENT WORTH COSTS					$280,790

04/26/94

TABLE DF-4.4
SITE 4: PUMP STATION AREA - WETLAND OPTION
EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 210 yd^3 (AST-7 soils contaminated with TPH, metals); cover material volume = 440 yd^3.

(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 10 samples.

(D) Assume use of existing Revetment Pad.

(E) Tilling once a week for project life period (4 hrs per week).

(F) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	210	1,050
(4)	Solidification equipment Mobilization/Demobilization	ea.	5000	1	5,000
(5)	Solidification equipment (year 2)	yd^3	30	210	6,300
(6)	Solidification agents (year 2)	yd^3	60	210	12,600
(7)	Land disposal of treated sediment (year 2)	yd^3	4	210	840
(8)	Apply cover material (year 2)	yd^3	4	440	1,760
			Subtotal		$42,550
(9)	Health and Safety at 10%			0.1	4,255
(10)	Engineering and Supervision at 20%			0.2	8,510
(11)	Contingency at 20%			0.2	8,510
		TOTAL CAPITAL COST			$64,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEAPS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	210	630
(2)	Soils Handling (tilling, etc., 4 hr/wk)	hrs	60	208	12,480
(3)	Confirmation soil sampling	ea.	500	10	5,000
			Subtotal		$18,110
(4)	Health and Safety at 10%			0.1	1,810
(5)	Engineering and Supervision at 20%			0.2	3,620
(6)	Contingency at 20%			0.2	3,620
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$27,160
TOTAL PRESENT WORTH COSTS					$111,140

04/26/94

TABLE DF-4.5
SITE 4: PUMP STATION AREA - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 210 yd^3 (AST-7 soils contaminated with TPH, metals); cover material volume = 440 yd^3.

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, land disposal, applying 3 feet of cover material, compacting, and site regrade.

(D) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 10 samples.

(E) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 3 units for project.

(F) Air monitoring costs $5,000 per event.

(G) Project life estimated at 6 months.

(H) Solidification equipment Mobilization/Demobilization estimated $5,000.

(I) Addition of solidification agents assumed at $60/yd3.

(J) Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $20/yd^3.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	25	210	5,250
(3)	Thermal Desorption	yd^3	100	210	21,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	10	5,000
(6)	GAC Units(regeneration, transportation)	ea.	800	3	2,400
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(9)	Solidification equipment	yd^3	30	210	6,300
(10)	Solidification agents	yd^3	60	210	12,600
(11)	Land disposal of treated sediment	yd^3	4	210	840
(12)	Apply cover material	yd^3	4	440	1,760
			Subtotal		$79,650
(13)	Health & Safety/ Air Monitoring at 10%			0.1	7,970
(14)	Engineering and Supervision at 30%			0.3	23,900
(15)	Contingency at 20%			0.2	15,930
		TOTAL CAPITAL COST			**$127,450**
TOTAL PRESENT WORTH COSTS					**$127,450**

04/26/94

TABLE DF-4.6
SITE 4: PUMP STATION AREA - WETLAND OPTION
OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 160 yd^3 @ 1.25 tons/yd^3 (AST-6 soils TPH and PAHs) cover material volume = 270 yd^3

(B) Soil will be transported to Rollins Facility in Deer Park, Texas.

(C) Incineration costs assumed to be $0.60/lb ($1,200/ton).

(D) Transportation cost assumed to be $250/ton.

(E) Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.

(F) No annual costs for this alternative. All costs incurred in first year.

(G) Addition of solidification agents assumed at $40/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	160	800
(3)	Transport to off-site facility	ton	250	200	50,000
(4)	Off-site Incineration	ton	1,200	200	240,000
(5)	Confirmation soil sampling	ea.	500	4	2,000
(6)	Apply cover material	yd^3	4	270	1,080
(7)	Solidification agents	yd^3	40	160	6,400
			Subtotal		$305,280
(9)	Engineering and Supervision at 10%			0.1	30,530
(10)	Contingency at 20%			0.2	61,060
			TOTAL CAPITAL COST		$396,870
TOTAL PRESENT WORTH COSTS					$396,870

05/05/94

TABLE DF-4.7
SITE 4: PUMP STATION AREA - WETLAND OPTION
CHEMICAL OXIDATION FOLLOWED BY
SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 160 yd^3 (AST-6 TPH and PAHs);
cover material volume = 270 yd^3.

(B) Chemical oxidation equipment assumed to be standard process equipment and assumed at $20,000. Assume use of existing Revetment Pad.

(C) Chemical oxidation costs (agents and manpower) estimated at $50 per yd^3.

(D) Soils placed in treatment unit after application to allow contaminant degradation. Assumed cost of unit = $20,000.

(E) Mixing soils for project life of 12 months. (8 hrs. per week)

(F) Confirmation soil samples will be taken from the bottom of the excavation to ensure adequate contaminant removal and to monitor the treatment process.

(G) Treated soil will be returned to the excavation area.

(H) Addition of solidification agents assumed at $50/$yd^3$.

(I) Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $20/$yd^3$.

(J) Extensive permitting costs are likely with this alternative.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Mobilization/Demobilization	ea.	10,000	1	10,000
	Chemical oxidation equipment	ea.	20,000	1	20,000
	Construction of treatment unit and storage pads	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	160	800
(3)	Chemical oxidation costs	yd^3	50	160	8,000
(4)	Soils Handling (mixing, etc., 8 hr/wk)	hr	60	416	24,960
(5)	Confirmation soil sampling	sample	1,000	4	4,000
(6)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(7)	Solidification equipment operation	yd^3	30	160	4,800
(8)	Solidification agents	yd^3	60	160	9,600
(9)	Land disposal of treated sediment	yd^3	4	160	640
(10)	Apply cover material	yd^3	4	270	1,080
			Subtotal		$98,880
(10)	Health and Safety at 10 %			0.1	9,890
(11)	Engineering and Supervision at 30%			0.3	29,660
(12)	Contingency at 20%			0.2	19,780
		TOTAL CAPITAL COST			$158,210
TOTAL PRESENT WORTH COSTS					$158,210

05/05/94

TABLE DF-4.8
SITE 4: PUMP STATION - WETLAND OPTION
SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 160 yd^3 (AST-6 TPH and PAHs); cover material volume = 270 yd^3.

(B) Soil washing to be completed by turn-key contractor. Two washes required, one for organics and one for metals.

(C) Soil washing costs (solvent and manpower) estimated at \$100/yd^3 for first wash, \$30/yd^3 for second wash.

(D) Confirmation samples taken from bottom of excavation to ensure adequate contamination removal and to monitor treatment process.

(E) Treated soil will be returned to excavated area.

(F) Project life estimated to be 12 months.

(G) No annual costs for this alternative. All costs incurred in first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	mobilization/demobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	160	800
(3)	Soil Washing Equipment Rental	month	10,000	12	120,000
(4)	Soil Washing Costs				
	(solvent and manpower)	yd^3	130	160	20,800
(5)	Confirmation samples	ea.	1,000	4	4,000
(6)	Land disposal of treated sediment	yd^3	4	160	640
(7)	Apply cover material	yd^3	4	270	1,080
			Subtotal		\$152,320
(7)	Health and Safety at 10%			0.1	15,230
(8)	Engineering and Supervision at 30%			0.3	45,700
(9)	Contingency at 20%			0.2	30,460
			TOTAL CAPITAL COST		**\$243,710**
TOTAL PRESENT WORTH COSTS					**\$243,710**

05/05/94

TABLE DF-4.9
SITE 4: PUMP STATION AREA SEDIMENTS - WETLAND OPTION OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Soil volume = 22,220 yd^3 at 1.25 tons/yd^3 (TPH, metals, pesticides); cover material volume = 33,330 yd^3

(B) Soil will be transported to Rollins Facility in Deer Park, Texas.

(C) Incineration costs assumed to be \$0.60/lb (\$1,200/ton).

(D) Transportation cost assumed to be \$250/ton.

(E) Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.

(F) No annual costs for this alternative. All costs incurred in first year.

(G) Addition of solidification agents assumed at \$40/yd^3.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	22,220	111,100
(3)	Transport to off-site facility	ton	250	27,780	6,945,000
(4)	Off-site Incineration	ton	1,200	27,780	33,336,000
(5)	Confirmation soil sampling	ea.	1,000	200	200,000
(6)	Apply cover material	yd^3	4	33,330	133,320
(7)	Solidification agents	yd^3	40	22,220	888,800
			Subtotal		\$41,619,220
(8)	Engineering and Supervision at 10%			0.1	4,161,920
(9)	Contingency at 20%			0.2	8,323,840
			TOTAL CAPITAL COST		\$54,104,980

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM-4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS \$54,104,980

05/05/94

TABLE DF 4.10
SITE 4: PUMP STATION AREA SEDIMENTS – WETLAND OPTION
CHEMICAL OXIDATION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 22,220 yd^3 (contaminated with TPH, metals, pesticides); cover material volume = 33,330 yd^3.

(B) Chemical oxidation equipment assumed to be standard process equipment and assumed at \$20,000. Assume use of existing Revetment Pad.

(C) Chemical oxidation costs (agents and manpower) estimated at \$50 per yd^3.

(D) Soils placed in treatment unit after application to allow contaminant degradation. Assumed cost of unit = \$20,000.

(E) Tilling soils once a week for project life of 6 months. (8 hrs. per week)

(F) Confirmation soil samples will be taken from the bottom of the excavation to ensure adequate contaminant removal and to monitor the treatment process. Assumed to include 10 samples.

(G) Treated soil will be returned to the excavation area.

(H) Addition of solidification agents assumed at \$50/yd^3.

(I) Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at \$20/yd^3.

(J) Extensive permitting costs are likely with this alternative.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Mobilization/Demobilization	ea.	10,000	1	10,000
	Chemical oxidation equipment	ea.	20,000	1	20,000
	Construction of treatment unit and storage pads	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	22,220	111,100
(3)	Chemical oxidation costs	yd^3	50	22,220	1,111,000
(4)	Soils Handling (mixing, etc., 40 hr/wk)	hr	60	2,080	124,800
(5)	Confirmation soil sampling	sample	1,000	200	200,000
(6)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(7)	Solidification equipment operation	yd^3	30	22,220	666,600
(8)	Solidification agents	yd^3	60	22,220	1,333,200
(9)	Land disposal of treated sediment	yd^3	4	22,220	88,880
(10)	Apply cover material	yd^3	4	33,330	133,320
			Subtotal		\$3,813,900
(10)	Health and Safety at 10 %			0.1	381,390
(11)	Engineering and Supervision at 30%			0.3	1,144,170
(12)	Contingency at 20%			0.2	762,780
		TOTAL CAPITAL COST			\$6,102,240

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS \$6,102,240

05/05/94

TABLE DF 4.11
SITE 4: PUMP STATION SEDIMENTS – WETLAND OPTION
SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 22,220 yd^3 (soil contaminated with TPH, metals, pesticides); cover material volume = 33,330 yd^3.

(B)Soil washing to be completed by turn–key contractor. Two washes required, one for organics and one for metals.

(C)Soil washing costs (solvent and manpower) estimated at \$100/yd^3 for first wash, \$30/yd^3 for second wash

(D)Confirmation samples taken from bottom of excavation to ensure adequate contamination removal and to monitor treatment process. Assumed 200 samples.

(E)Treated soil will be returned to excavated area.

(F)Project life estimated to be 12 months.

(G)No annual costs for this alternative. All costs incurred in first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	mobilization/demobilization	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	22,220	111,100
(3)	Soil Washing Equipment Rental	month	10,000	12	120,000
(4)	Soil Washing Costs				
	(solvent and manpower)	yd^3	130	22,220	2,888,600
(5)	Confirmation samples	ea.	1,000	200	200,000
(6)	Land disposal of treated sediment	yd^3	4	22,220	88,880
(7)	Apply cover material	yd^3	4	33,330	133,320
			Subtotal		\$3,546,900
(7)	Health and Safety at 10%			0.1	354,690
(8)	Engineering and Supervision at 30%			0.3	1,064,070
(9)	Contingency at 20%			0.2	709,380
			TOTAL CAPITAL COST		**\$5,675,040**

ANNUAL OPERATIONS AND MAINTENANCE COST, MONITORING (20 YEARS)

NOTE: Refer to Table DWM–4 for groundwater monitoring costs.

TOTAL PRESENT WORTH COSTS **\$5,675,040**

05/05/94

TABLE DF–5.1
SITE 5: FORMER SEWAGE TREATMENT PLANT – WETLAND OPTION
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A)No groundwater monitoring, no soil treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
		TOTAL CAPITAL COST			$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
		TOTAL ANNUAL O & M COST			$0
TOTAL PRESENT WORTH COSTS					$0

04/24/94

TABLE DF-5.2
SITE 5: FORMER SEWAGE TREATMENT PLANT - WETLAND OPTION
OFF-SITE THERMAL DESTRUCTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Soil volume = 1,200 yd^3 at 1.25 tons/yd^3 (TPH, PCBs, pesticides, metals); cover material volume = 1,940 yd^3.
(B)Soil will be transported to Rollins Facility in Deer Park, Texas.
(C)Incineration costs assumed to be $0.60/lb ($1,200/ton)
(D)Transportation cost assumed to be $250/ton
(E)Confirmation soil samples will be taken at the bottom of excavation to ensure contamination removal.
(F)No annual costs for this alternative. All costs incurred in first year.
(G)Addition of solidification agents assumed at $40/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation (mobilization)	ea.	5,000	1	5,000
(2)	Excavation	yd^3	5	1,200	6,000
(3)	Transport to Off-site Facility	ton	250	1,500	375,000
(4)	Off-site Incineration	ton	1,200	1,500	1,800,000
(5)	Confirmation soil sampling	ea.	1,000	6	6,000
(6)	Backfill with onsite soils	yd^3	4	1,940	7,760
(7)	Solidification agents	yd^3	40	1,200	48,000
			Subtotal		$2,247,760
(8)	Engineering and Supervision at 10%			0.1	224,780
(9)	Contingency at 10%			0.1	224,780
		TOTAL CAPITAL COST			$2,697,320
TOTAL PRESENT WORTH COSTS					$2,697,320

04/26/94

TABLE DF-5.3
SITE 5: FORMER SEWAGE TREATMENT PLANT - WETLAND OPTION CHEMICAL OXIDATION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 1,200 yd^3 (TPH, PCBs, pesticides, metals); cover material volume = 1,940 yd^3.

(B)Chemical oxidation equipment assumed to be standard process equipment and assumed at $20,000.

(C)Chemical oxidation costs (agents and manpower) estimated at $50 per yd^3.

(D)Soils placed in treatment unit after application to allow contaminant degradation. Assumed cost of unit = $10,000.

(E)Mixing soils 16 hrs per week. Project life of 6 months.

(F)Confirmation soil samples will be taken from the bottom of the excavation to ensure adequate contaminant removal and to monitor the treatment process. Assumed to include 10 samples.

(G)Treated soil will be returned to the excavation area.

(H)Extensive permitting costs are likely with this alternative.

(I)Soilification equipment includes screening, shredding, and pugmil with assumed rental costs at $30/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	Mobilization/Demobilization	ea.	10,000	1	10,000
	Chemical oxidation equipment	ea.	20,000	1	20,000
	Construction of treatment unit and storage pads	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	1,200	6,000
(3)	Chemical oxidation costs	yd^3	50	1,200	60,000
(4)	Soils Handling (mixing, etc., 16 hr/wk)	hr	60	832	49,920
(5)	Confirmation soil sampling	sample	1,000	10	10,000
(6)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(7)	Solidification equipment operation	yd^3	30	560	16,800
(8)	Solidification agents	yd^3	60	560	33,600
(9)	Backfill excavation site	yd^3	4	1,940	7,760
			Subtotal		$229,080
(10)	Health and Safety at 10 %			0.1	22,910
(11)	Engineering and Supervision at 30%			0.3	68,720
(12)	Contingency at 20%			0.2	45,820
		TOTAL CAPITAL COST			$366,530
TOTAL PRESENT WORTH COSTS					$366,530

04/26/94

TABLE DF-5.4
SITE 5: FORMER SEWAGE TREATMENT PLANT - WETLAND OPTION
SOIL WASHING COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 1,200 yd^3 (TPH, PCBs, pesticides, metals); cover material volume = 1,940 yd^3.

(B) Soil washing to be completed by turn-key contractor. Two washes required, one for organics and one for metals.

(C) Soil washing costs (solvent and manpower) estimated at \$100/yd^3 for first wash, \$30/yd^3 for second.

(D) Confirmation samples taken from bottom of excavation to ensure adequate contamination removal and to monitor treatment process. Assumed 10 samples.

(E) Treated soil will be returned to excavated area.

(F) Project life estimated to be 6 months.

(G) No annual costs for this alternative. All costs incurred in first year.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Site Preparation				
	mobilization/demobilization	ea.	5,000	1	5,000
	construction of treatment and storage pad	ea.	10,000	1	10,000
(2)	Excavation	yd^3	5	1,200	6,000
(3)	Soil Washing Equipment Rental	month	10,000	6	60,000
(4)	Soil Washing Costs				
	(solvent and manpower)	yd^3	130	1,200	156,000
(5)	Confirmation samples	ea.	1,000	10	10,000
(6)	Backfill excavation site	yd^3	4	1,940	7,760
			Subtotal		\$254,760
(7)	Health and Safety at 10%			0.1	25,480
(8)	Engineering and Supervision at 30%			0.3	76,430
(9)	Contingency at 20%			0.2	50,950
			TOTAL CAPITAL COST		\$407,620
TOTAL PRESENT WORTH COSTS					\$407,620

04/26/94

TABLE DF-6.1
SITE 6: EAST LEVEE LANDFILL - WETLAND OPTIONS
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) No groundwater monitoring, no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
		TOTAL CAPITAL COST			$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
		TOTAL ANNUAL O & M COST			$0
TOTAL PRESENT WORTH COSTS					$0

04/25/94

TABLE DF-6.2
SITE 6: EAST LEVEE LANDFILL - WETLAND OPTION
EXCAVATION, BIOTREATMENT AND SOLIDIFICATION/STABILIZATION
COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 280 yd^3 (soils contaminated with TPH, metals); cover material volume = 7,500 yd^3.

(B) Application of nutrients and micro-organisms estimated at \$3/yd^3.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal, and to monitor biodegradation and solidification/stabilization effectiveness. Assume 4 samples.

(D) Assume use of existing Revetment Pad.

(E) Tilling once a week for project life period (6 hrs per week).

(F) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	280	1,400
(4)	Solidification equipment	yd^3	30	280	8,400
(5)	Solidification agents	yd^3	60	280	16,800
(6)	Land disposal of treated soil (year 2)	yd^3	4	280	1,120
(7)	Apply cover material (year 2)	yd^3	4	7,500	30,000
			Subtotal		\$72,720
(8)	Health and Safety at 10%			0.1	7,272
(9)	Engineering and Supervision at 20%			0.2	14,544
(10)	Contingency at 20%			0.2	14,544
		TOTAL CAPITAL COST			**\$109,000**
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	280	840
(2)	Soils Handling (tilling, etc., 6 hr/wk)	hrs	60	312	18,720
(3)	Confirmation soil sampling	ea.	500	4	2,000
			Subtotal		\$21,560
(4)	Health and Safety at 10%			0.1	2,160
(5)	Engineering and Supervision at 20%			0.2	4,310
(6)	Contingency at 20%			0.2	4,310
		TOTAL ANNUAL O & M COST (0-2 YEARS)			**\$32,340**
TOTAL PRESENT WORTH COSTS					**\$165,130**

05/03/94

TABLE DF-6.3
SITE 6: EAST LEVEE LANDFILL - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION AND SOLIDIFICATION/ STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 280 yd^3 (TPH, metals); cover material volume = 7,500 yd^3.

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, land disposal, applying 3 feet of cover material, compacting, and site regrade.

(D) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process and solidification/ stabilization effectiveness. Assumed to include 4 samples.

(E) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 2 units for project.

(F) Air monitoring costs $5,000 per event.

(G) Project life estimated at 6 months.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads	ea.	1	8,000	8,000
(2)	Soils Handling	yd^3	25	280	7,000
(3)	Thermal Desorption	yd^3	100	280	28,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	4	2,000
(6)	GAC Units(regeneration, transportation)	ea.	800	2	1,600
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Solidification equipment	yd^3	30	280	8,400
(9)	Solidification agents	yd^3	60	280	16,800
(10)	Land disposal of treated soil	yd^3	4	280	1,120
(11)	Apply cover material	yd^3	4	7500	30,000
			Subtotal		$114,420
(12)	Health & Safety/ Air Monitoring at 10%			0.1	11,440
(13)	Engineering and Supervision at 30%			0.3	34,330
(14)	Contingency at 20%			0.2	22,880
		TOTAL CAPITAL COST			$183,070
TOTAL PRESENT WORTH COSTS					$183,070

05/03/94

TABLE DF-7.1.1
SITE 7: AIRCRAFT MAINTENANCE SOIL - WETLAND OPTION
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) No groumdwater monitoring, no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
			TOTAL CAPITAL COST		$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
			TOTAL ANNUAL O & M COST		$0
TOTAL PRESENT WORTH COSTS					$0

04/26/94

TABLE DF-7.1.2
SITE 7: AIRCRAFT MAINTENANCE SOIL - WETLAND OPTION EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A)Contaminated soil volume = 660 yd^3; Cover material = 68,600 yd^3

(B)Application of nutrients and micro-organisms estimated at \$3/yd^3.

(C)Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 6 samples.

(D)Assume use of existing Revetment Pad.

(E)Treated soils will be returned to excavated area.

(F)Tilling once a week for project life period (4 hrs per week).

(G)Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Soil Excavation	yd^3	5	660	3,300
(4)	solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(5)	Solidifcation equipment (year 2)	yd^3	30	660	19,800
(6)	Solidification agents (year 2)	yd^3	60	660	39,600
(7)	Backfill excavation site (at end of project)	yd^3	4	660	2,640
(8)	Apply cover material	yd^3	4	68,600	274,400
			Subtotal		\$364,740
(9)	Health and Safety at 10%			0.1	36,474
(10)	Engineering and Supervision at 20%			0.2	72,948
(11)	Contingency at 20%			0.2	72,948
			TOTAL CAPITAL COST		\$547,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	660	1,980
(2)	Soils Handling (tilling, etc., 4 hr/wk)	hrs	60	208	12,480
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		\$17,460
(4)	Health and Safety at 10%			0.1	1,750
(5)	Engineering and Supervision at 20%			0.2	3,490
(6)	Contingency at 20%			0.2	3,490
			TOTAL ANNUAL O & M COST (0-2 YEARS)		\$26,190
TOTAL PRESENT WORTH COSTS					\$592,450

04/28/94

TABLE DF-7.1.3
SITE 7: AIRCRAFT MAINTENANCE SOILS - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION COST ESTIMATE
SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 660 yd^3; cover material = 68,600 yd^3.

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, backfilling, compacting, and site regrade.

(D) Treated soil will be returned to excavated area.

(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 6 samples.

(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 1 unit for project.

(G) Air monitoring costs $5,000 per event.

(H) Project life estimated at 4 months.

(I) No annual costs for this alternative. All first year costs.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads	ea.	8,000	1	8,000
(2)	Soils Handling	yd^3	25	660	16,500
(3)	Thermal Desorption	yd^3	100	660	66,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation Sampling	sample	500	6	3,000
(6)	GAC Units (regeneration, transportation)	ea.	2,000	1	2,000
(7)	Solidification equipment Mobilization/Demobilization	ea.	5,000	1	5,000
(8)	Solidification equipment (year 2)	yd^3	30	660	19,800
(9)	Solidification agents (year 2)	yd^3	60	660	39,600
(10)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(11)	Apply cover material	yd^3	4	68,600	274,400
			Subtotal		$445,800
(12)	Health & Safety at 10%			0.1	44,580
(13)	Engineering and Supervision at 20%			0.2	89,160
(14)	Contingency at 20%			0.2	89,160
			TOTAL CAPITAL COST		$668,700
TOTAL PRESENT WORTH COSTS					$668,700

04/28/94

TABLE DF-7.2.1
SITE 7: AIRCRAFT MAINTENANCE-SEDIMENT-WETLAND OPTION
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) No groundwater monitoring, no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
		TOTAL CAPITAL COST			$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
		TOTAL ANNUAL O & M COST			$0
TOTAL PRESENT WORTH COSTS					$0

04/26/94

TABLE DF-7.2.2
SITE 7: AIRCRAFT MAINTENANCE - SEDIMENT - WETLAND OPTION BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 2,220 yd^3 (soils contaminated with TPH, metals); cover material = 3,330 yd^3.

(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 10 samples.

(D) Assume use of an existing pad.

(E) Treated soils will be returned to excavated area.

(F) Tilling once a week for project life period (16 hrs per week).

(G) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	15,000	1	15,000
(3)	Solidification mobilization/demobization	ea.	5,000	1	5,000
(4)	Solidification equipment (year 2)	yd^3	30	2,220	66,600
(5)	Solidification agents (year 2)	yd^3	60	2,220	133,200
(6)	Cap with 3 feet of fill	yd^3	4	3,330	13,320
			Subtotal		$238,120
(7)	Health and Safety at 10%			0.1	23,810
(8)	Engineering and Supervision at 20%			0.2	47,620
(9)	Contingency at 20%			0.2	47,620
	TOTAL CAPITAL COST				$357,170
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	2,220	6,660
(2)	Soils Handling (tilling, 16 hr/week)	hrs	60	832	49,920
(3)	Confirmation soil sampling	ea.	500	10	5,000
			Subtotal		$61,580
(4)	Health and Safety at 10%			0.1	6,160
(5)	Engineering and Supervision at 20%			0.2	12,320
(6)	Contingency at 20%			0.2	12,320
	TOTAL ANNUAL O & M COST (0-2 YEARS)				$92,380
TOTAL PRESENT WORTH COSTS					$517,500

04/28/94

TABLE DF-7.2.3
SITE 7: AIRCRAFT MAINTENANCE - SEDIMENT - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 2,220 yd^3 (TPH, metals); cover material = 3,330 yd^3.
(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of an existing pad.
(C) Soils handling includes excavation, backfilling, compacting, and site regrade.
(D) Treated soil will be returned to excavated area.
(E) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process. Assumed to include 10 samples.
(F) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $2,000 per unit. Assume 2 units for project.
(G) Project life estimated at 6 months.
(H) Addition of solidification agents assumed at $60/$yd^3$.
(I) Solidification equipment includes screening, shredding, and pugmill with assumed rental costs at $30/$yd^3$.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				10,000
(2)	Soils Handling	yd^3	25	2,220	55,500
(3)	Thermal Desorption	yd^3	100	2,220	222,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	10	5,000
(6)	GAC Units(regeneration, transportation)	ea.	2,000	2	4,000
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	3	4,500
(8)	Solidification mobilization/demobilization	ea.	5,000	1	5,000
(9)	Solidification equipment	yd^3	30	2,220	66,600
(10)	Solidification agents	yd^3	60	2,220	133,200
(11)	Cap with 3 feet of fill	yd^3	4	3,330	13,320
			Subtotal		$529,120
(12)	Health & Safety/ Air Monitoring at 10%			0.1	52,910
(13)	Engineering and Supervision at 30%			0.3	158,740
(14)	Contingency at 20%			0.2	105,820
		TOTAL CAPITAL COST			$846,590
TOTAL PRESENT WORTH COSTS					$846,590

04/28/94

TABLE DF-8.1
SITE 8: FUEL LINES - WETLAND OPTIONS
NO ACTION COST ESTIMATE

ASSUMPTIONS:

(A) No groundwater, no soils treatment.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
		TOTAL CAPITAL COST			$0
ANNUAL OPERATIONS AND MAINTENANCE COST (30 YEARS)					
		TOTAL ANNUAL O & M COST			$0
TOTAL PRESENT WORTH COSTS					$0

04/26/94

TABLE DF-8.2
SITE 8: FUEL LINES - WETLAND OPTION
EXCAVATION, BIOTREATMENT, AND SOLIDFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 670 yd^3 (soils contaminated with TPH, metals)
Cover material volume = 1,830 yd^3.

(B) Application of nutrients and micro-organisms estimated at $3/$yd^3$.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation and solidification/stabilization effectiveness. Assume 6 samples.

(D) Assume use of existing Revetment Pad.

(E) Tilling once a week for project life period (6 hrs per week).

(F) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	670	3,350
(4)	Solidification equipment	yd^3	30	670	20,100
(5)	Solidification agents	yd^3	60	670	40,200
(6)	Land disposal of treated sediment (year 2)	yd^3	4	670	2,680
(7)	Apply cover material (year 2)	yd^3	4	1,830	7,320
			Subtotal		$88,650
(8)	Health and Safety at 10%			0.1	8,865
(9)	Engineering and Supervision at 20%			0.2	17,730
(10)	Contingency at 20%			0.2	17,730
			TOTAL CAPITAL COST		$133,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	670	2,010
(2)	Soils Handling (tilling, etc., 6 hr/wk)	hrs	60	670	40,200
(3)	Confirmation soil sampling	ea.	500	6	3,000
			Subtotal		$45,210
(4)	Health and Safety at 10%			0.1	4,520
(5)	Engineering and Supervision at 20%			0.2	9,040
(6)	Contingency at 20%			0.2	9,040
			TOTAL ANNUAL O & M COST (0-2 YEARS)		$67,810
TOTAL PRESENT WORTH COSTS					$250,690

05/03/94

TABLE DF-8.3
SITE 8: FUEL LINES - WETLAND OPTION
LOW TEMPERATURE THERMAL DESORPTION AND SOLIDIFICATION/ STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 670 yd^3 (TPH, metals); cover material volume = 1,830 yd^3.

(B) Low temperature thermal desorption to be completed by turn-key operator. Costs assumed at $8,000 to include mobilization/demobilization and construction as needed. Assume use of existing Revetment Pad.

(C) Soils handling includes excavation, land disposal, applying 3 feet of cover material, compacting, and site regrade.

(D) Confirmation soil samples taken from the bottom of the excavation to ensure adequate contaminant removal, and to monitor the treatment process and solidification/ stabilization effectiveness. Assumed to include 4 samples.

(E) Both the organic phase liquid condensate and the spent granular activated carbon (GAC) will require off-site treatment. GAC transportation, rental and regeneration costs assumed at $800 per unit. Assume 2 units for project.

(F) Air monitoring costs $5,000 per event.

(G) Project life estimated at 6 months.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization, Site Preparation, Construction of storage pads				8,000
(2)	Soils Handling	yd^3	25	670	16,750
(3)	Thermal Desorption	yd^3	100	670	67,000
(4)	Stack Air Monitoring	event	5,000	2	10,000
(5)	Confirmation soil sampling	sample	500	6	3,000
(6)	GAC Units(regeneration, transportation)	ea.	800	2	1,600
(7)	Off-site recycle/disposal of organic phase liquids	ea.	1,500	1	1,500
(8)	Land disposal of treated soil	yd^3	4	670	2,680
(9)	Solidification equipment	yd^3	30	670	20,100
(10)	Solidification agents	yd^3	60	670	40,200
(11)	Apply cover material	yd^3	4	1,830	7,320
			Subtotal		$178,150
(12)	Health & Safety/ Air Monitoring at 10%			0.1	17,820
(13)	Engineering and Supervision at 30%			0.3	53,450
(14)	Contingency at 20%			0.2	35,630
		TOTAL CAPITAL COST			$285,050
TOTAL PRESENT WORTH COSTS					$285,050

05/03/94

TABLE DF-10
CENTRALIZED TREATMENT
SITES 2 THROUGH 8: TPH - WETLAND OPTION
EXCAVATION AND BIOTREATMENT COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 27,700 yd^3, based on total volume of TPH (>100 mg/kg) at sites 2,3,4 (AST-5, stockpile); cover material = 79,870 yd^3.

(B) Application of nutrients and micro-organisms estimated at \$3/yd^3.

(C) Confirmation soil samples will be taken to monitor biodegration. Assume 120 samples.

(D) Tilling project life period (40 hrs per week).

(E) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	100,000	1	100,000
(3)	Soil Excavation	yd^3	5	27,700	138,500
(4)	Backfill excavation site (at end of project)	yd^3	4	27,700	110,800
(5)	Apply cover material	yd^3	4	79,870	319,480
			Subtotal		\$673,780
(6)	Health and Safety at 10%			0.1	67,378
(7)	Engineering and Supervision at 20%			0.2	134,756
(8)	Contingency at 20%			0.2	134,756
		TOTAL CAPITAL COST			\$1,011,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	27,700	83,100
(2)	Soils Handling (tilling, etc., 40 hr/wk)	hrs	60	2,100	126,000
(3)	Confirmation soil sampling	ea.	500	120	60,000
			Subtotal		\$269,100
(4)	Health and Safety at 10%			0.1	26,910
(5)	Engineering and Supervision at 20%			0.2	53,820
(6)	Contingency at 20%			0.2	53,820
	TOTAL ANNUAL O & M COST (0-2 YEARS)				\$403,650
TOTAL PRESENT WORTH COSTS					\$1,711,550

05/04/94

TABLE DF-11
CENTRALIZED TREATMENT
SITES 2 THROUGH 8: TPH AND METALS - WETLAND OPTION
EXCAVATION AND BIOTREATMENT FOLLOWED BY SOLIDIFICATION/STABILIZATION COST ESTIMATE

ASSUMPTIONS:

(A) Contaminated soil volume = 1,540 yd^3, based on total volume of soil contaminated with both TPH and metals (AST-7, Fuel Lines, and aircraft maintenance soils); cover material = 79,870 yd^3

(B) Application of nutrients and micro-organisms estimated at $\$3/yd^3$.

(C) Confirmation soil samples will be taken at the bottom of the excavation to ensure contamination removal and to monitor biodegradation. Assume 22 samples.

(D) Assume use of existing Revetment Pad.

(E) Tilling once a week for project life period (12 hrs per week).

(F) Project life estimated at 2 years.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMT.	COST
CAPITAL COST					
(1)	Mobilization/Demobilization	ea.	5,000	1	5,000
(2)	Biological treatment unit construction	ea.	10,000	1	10,000
(3)	Soil Excavation	yd^3	5	1,540	7,700
(4)	Solidification equipment Mobilization/Demobilization	ea.	5000	1	5,000
(5)	Solidification equipment (year 2)	yd^3	30	1,540	46,200
(6)	Solidification agents (year 2)	yd^3	60	1,540	92,400
(7)	Land disposal of treated soil (year 2)	yd^3	4	1,540	6,160
(8)	Apply cover material	yd^3	4	70,870	283,480
			Subtotal		$455,940
(9)	Health and Safety at 10%			0.1	45,594
(10)	Engineering and Supervision at 20%			0.2	91,188
(11)	Contingency at 20%			0.2	91,188
			TOTAL CAPITAL COST		$684,000
ANNUAL OPERATIONS AND MAINTENANCE (0-2 YEARS)					
(1)	Biotreatment, nutrients and microorganisms	yd^3	3	1,540	4,620
(2)	Soils Handling (tilling, etc., 12 hr/wk)	hrs	60	624	37,440
(3)	Confirmation soil sampling	ea.	500	18	9,000
			Subtotal		$51,060
(4)	Health and Safety at 10%			0.1	5,110
(5)	Engineering and Supervision at 20%			0.2	10,210
(6)	Contingency at 20%			0.2	10,210
			TOTAL ANNUAL O & M COST (0-2 YEARS)		$76,590
TOTAL PRESENT WORTH COSTS					$816,920

05/04/94

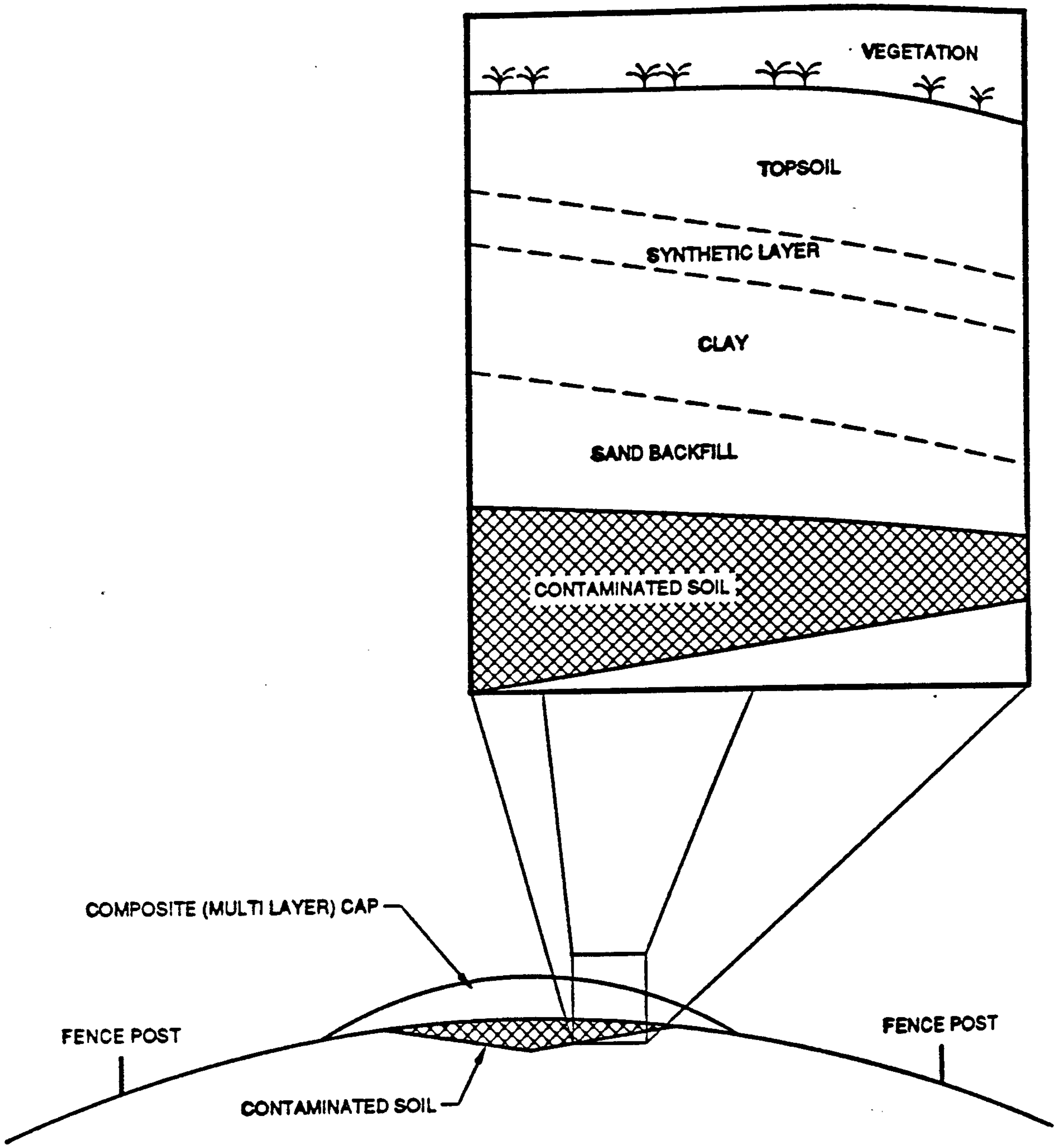
APPENDIX E

FLOW DIAGRAMS

APPENDIX E

PROCESS FLOW DIAGRAMS

List of Diagrams

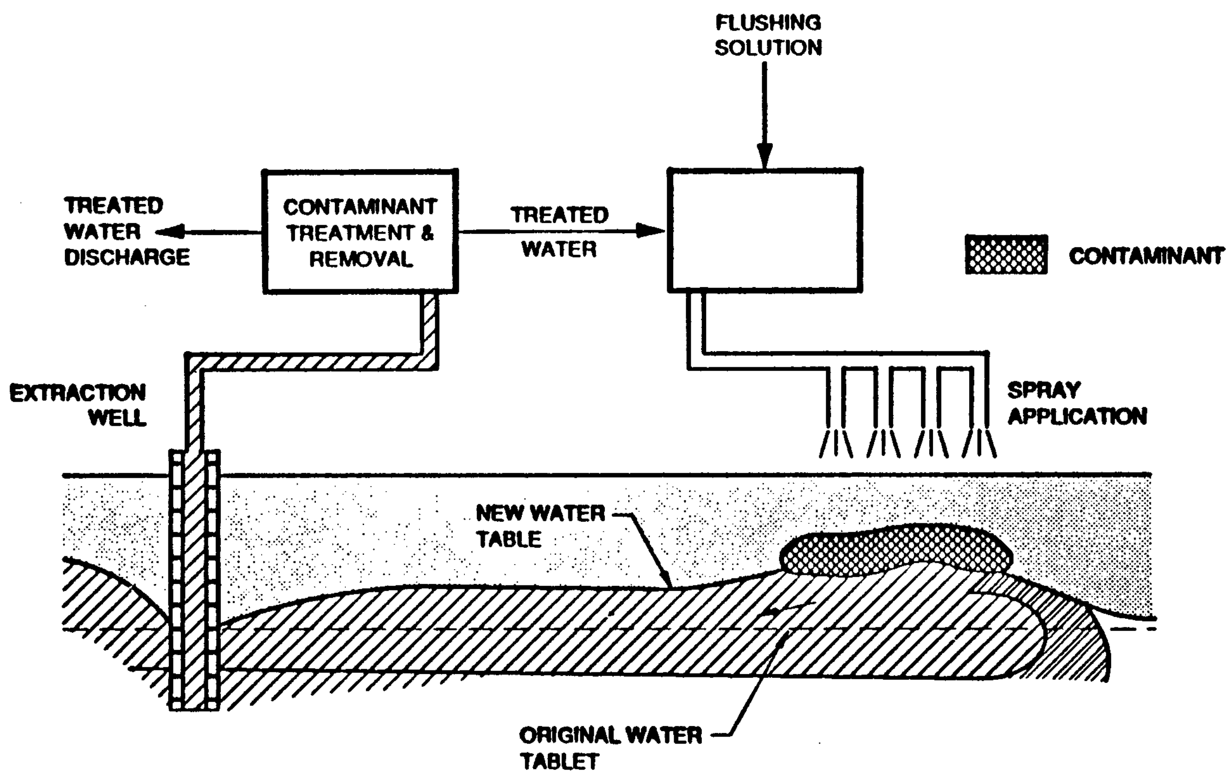


USATHAMA
Hamilton Army Airfield

S2: CAPPING

SOIL REMEDIAL ALTERNATIVE

ENGINEERING-SCIENCE



USATHAMA

Hamilton Army Airfield

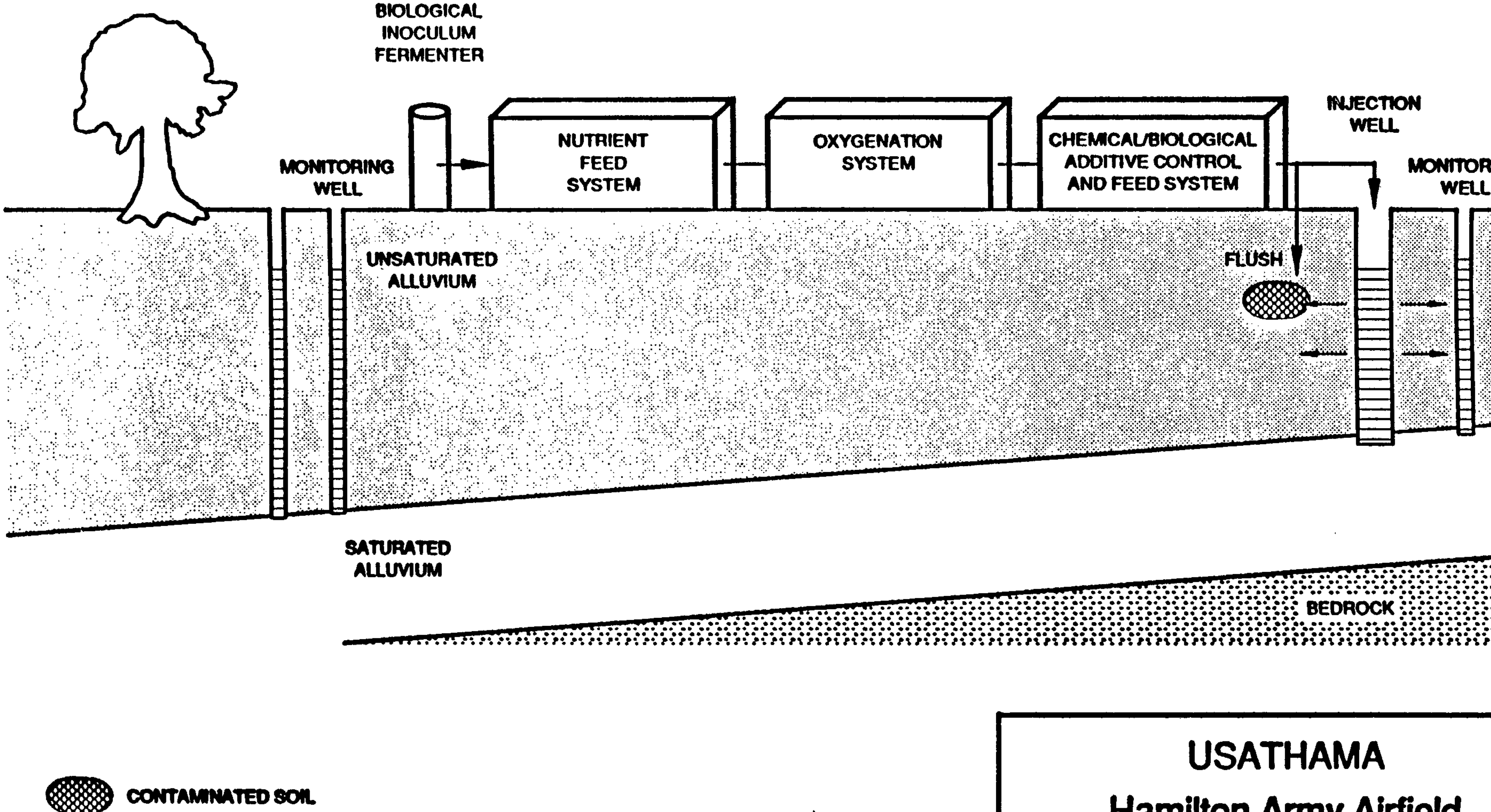
S3: INSITU SOIL FLUSHING

SOIL REMEDIAL ALTERNATIVE

SOURCE: EPA/540/2-88/003(1)

C20-12.R1 9/5/91

ENGINEERING-SCIENCE



USATHAMA

Hamilton Army Airfield

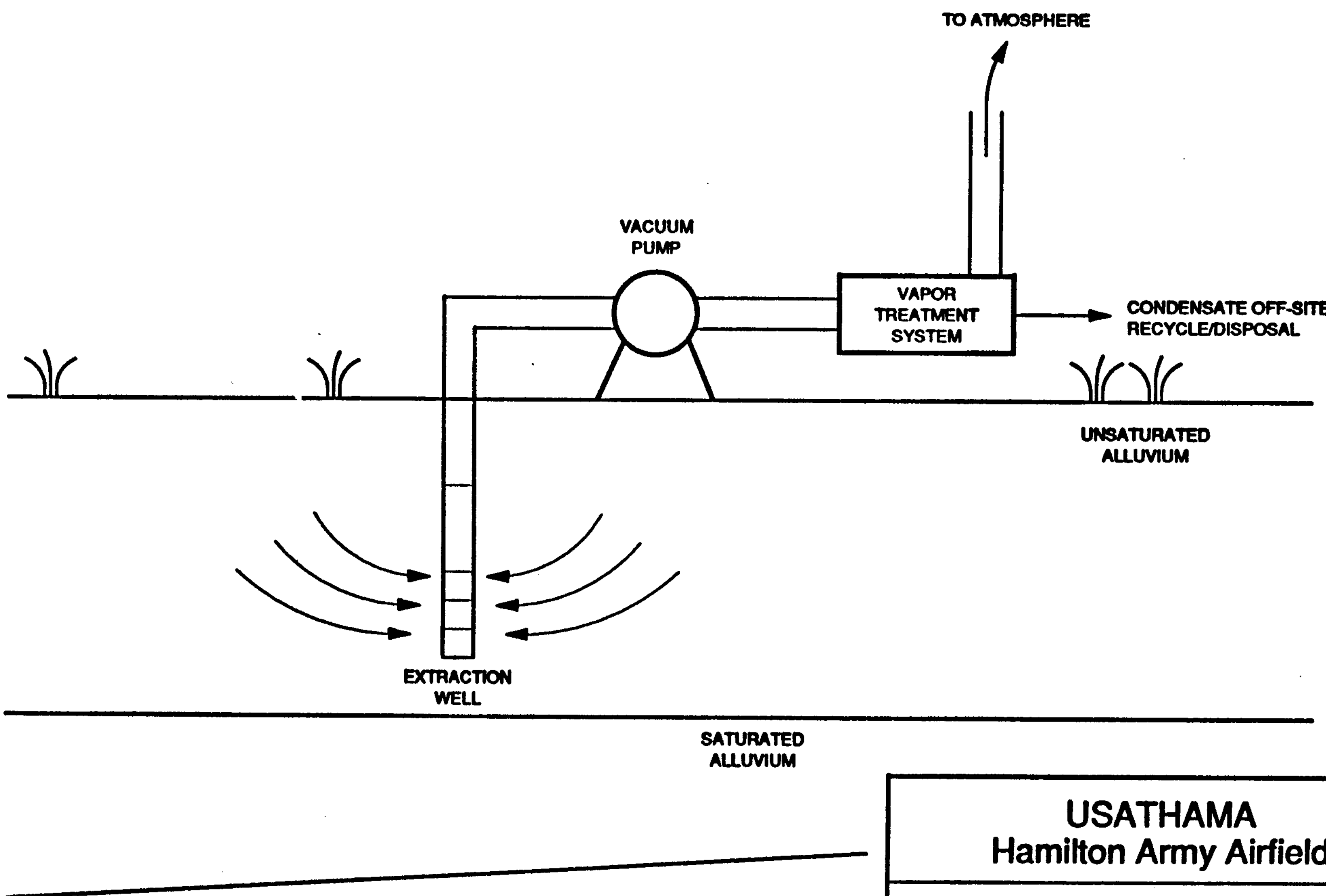
S4: BIOREMEDIATION (IN-SITU)

SOIL REMEDIAL ALTERNATIVE

SOU[illegible] Corp.

C[illegible]-11.R1 9[illegible]

ENGINEERING-SCIENCE



USATHAMA
Hamilton Army Airfield

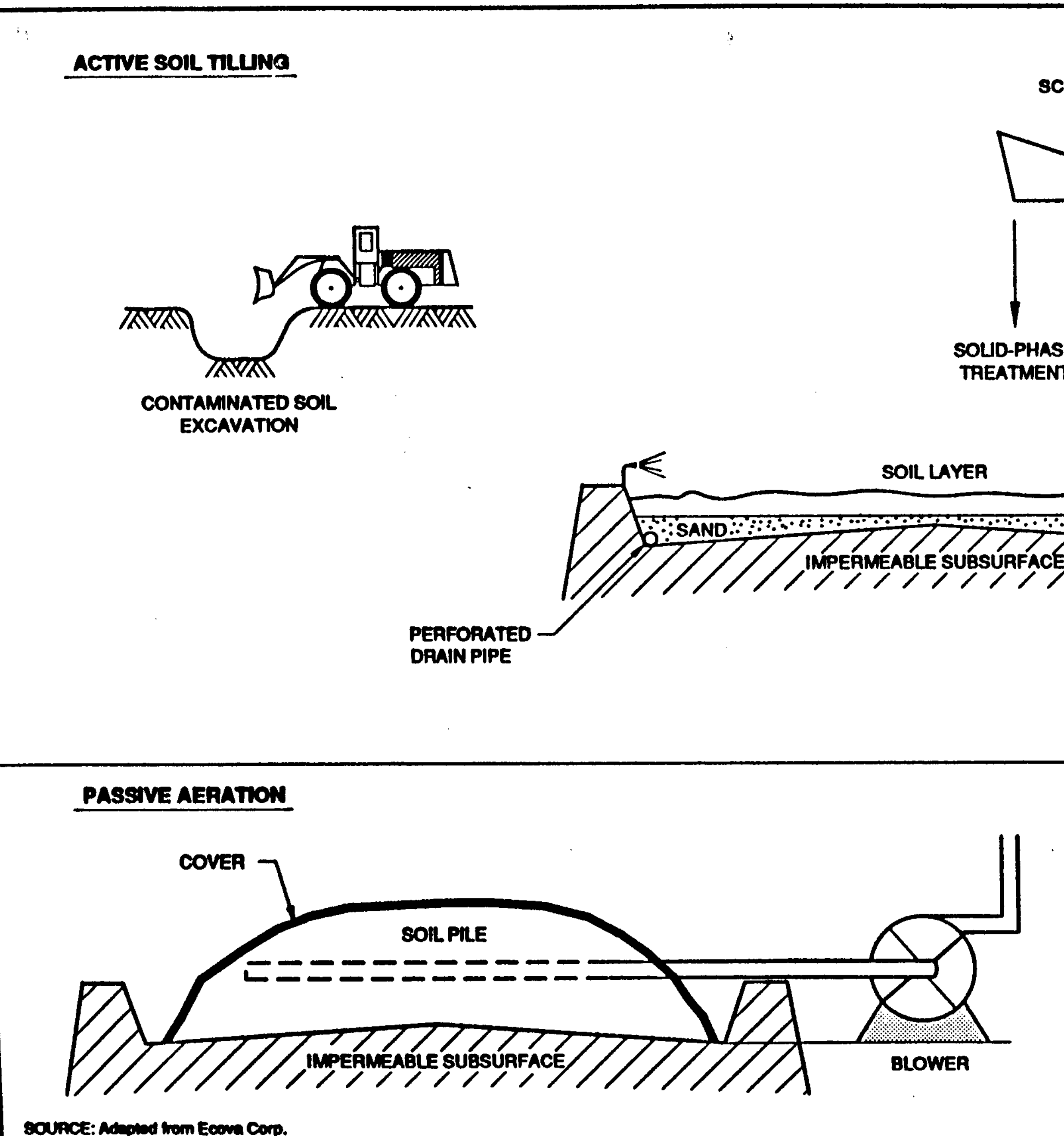
S5: IN SITU SOIL VAPOR EXTRACTION

SOIL REMEDIAL ALTERNATIVE

SOURCE: Adapted from CDM

C236-21.R1 1/1693

ENGINEERING-SCIENCE, INC.



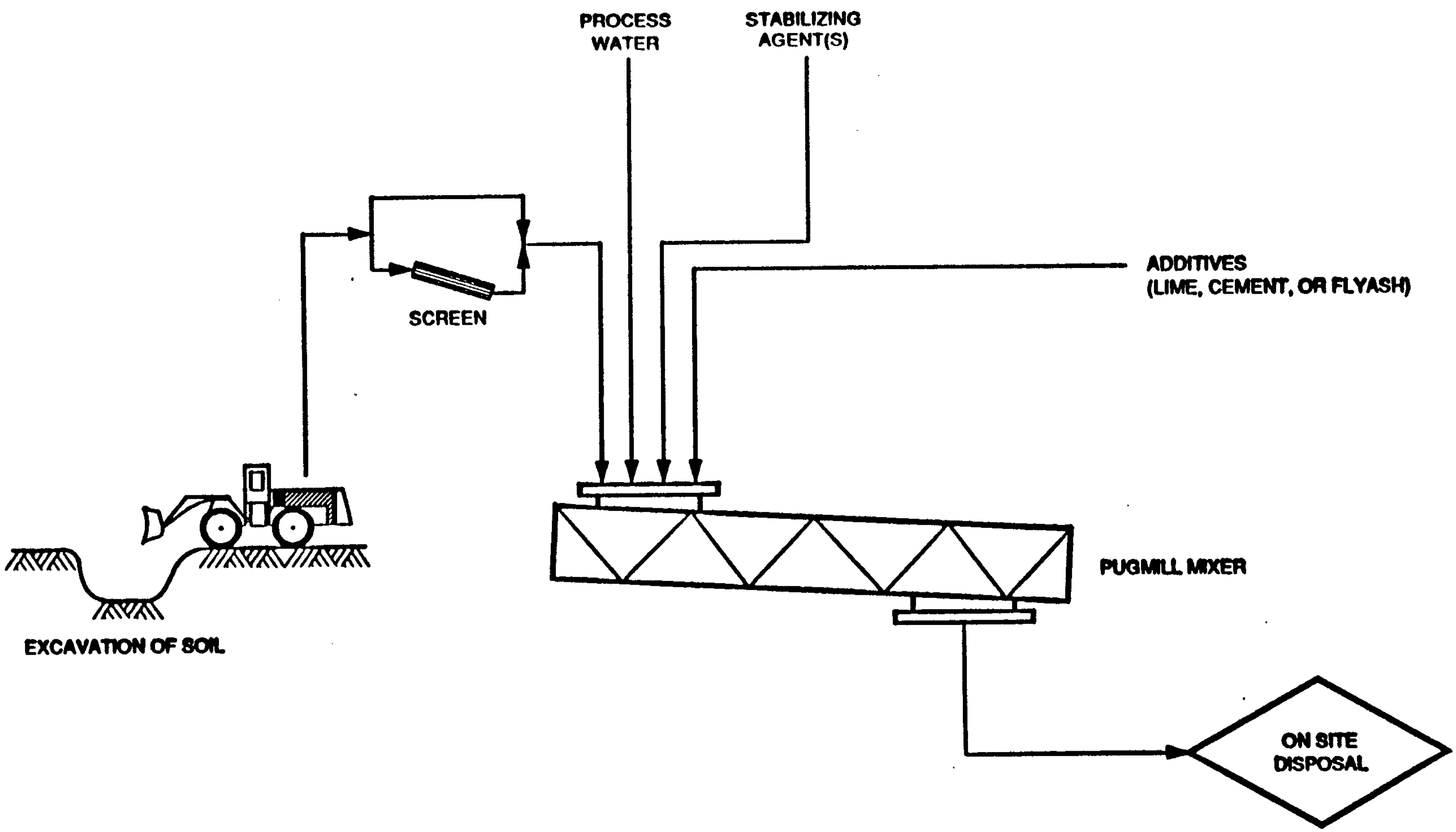
USATHAMA
Hamilton Army Airfield

S6: EXCAVATION AND BIOTREATMENT

SOIL REMEDIAL ALTERNATIVE

C331-10.R0 12/17/92

ENGINEERING-SCIENCE, INC.



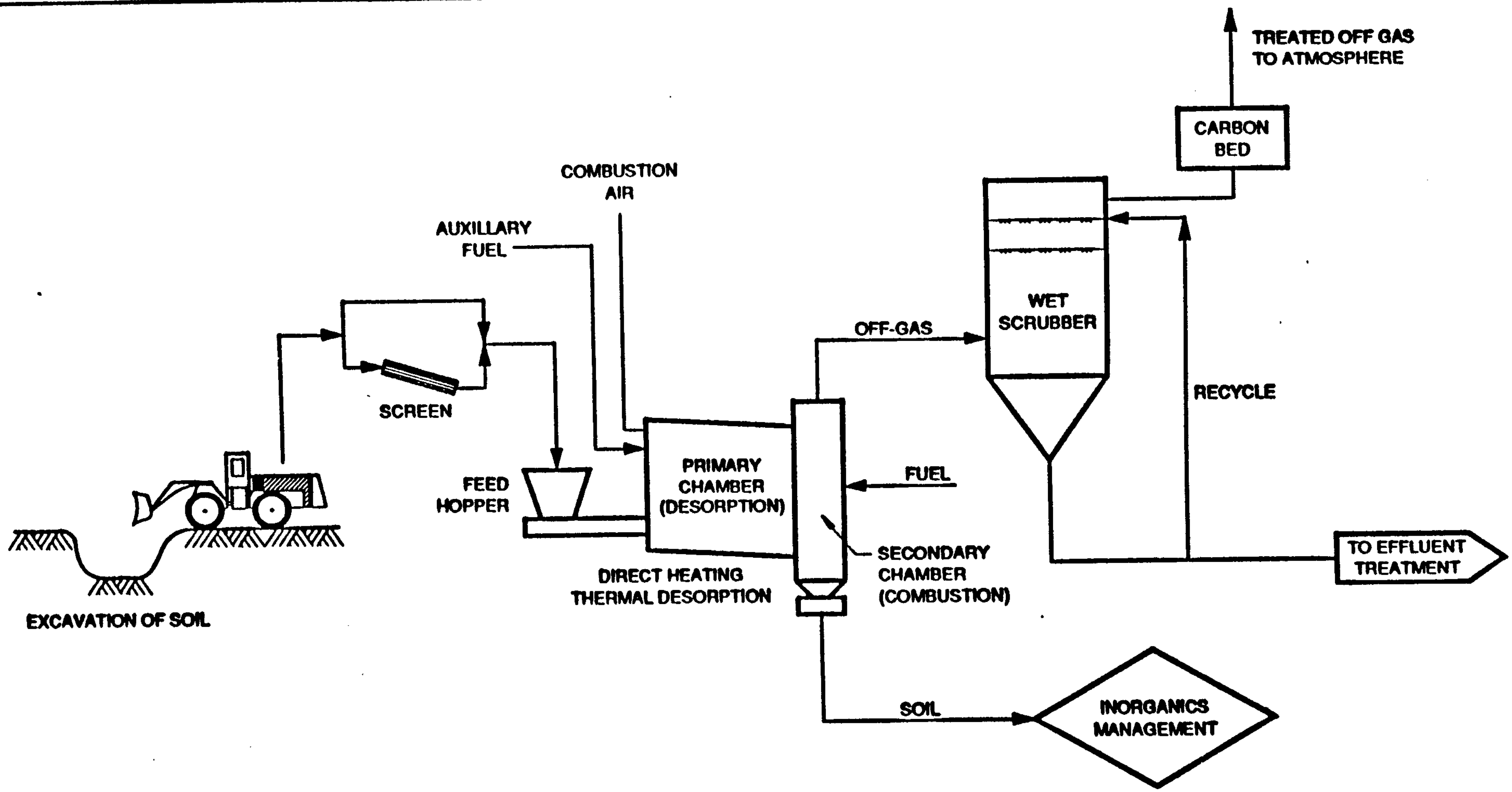
USATHAMA

Hamilton Army Airfield

S7: SOLIDIFICATION/ STABILIZATION

SOIL REMEDIAL ALTERNATIVE

ENGINEERING-SCIENCE



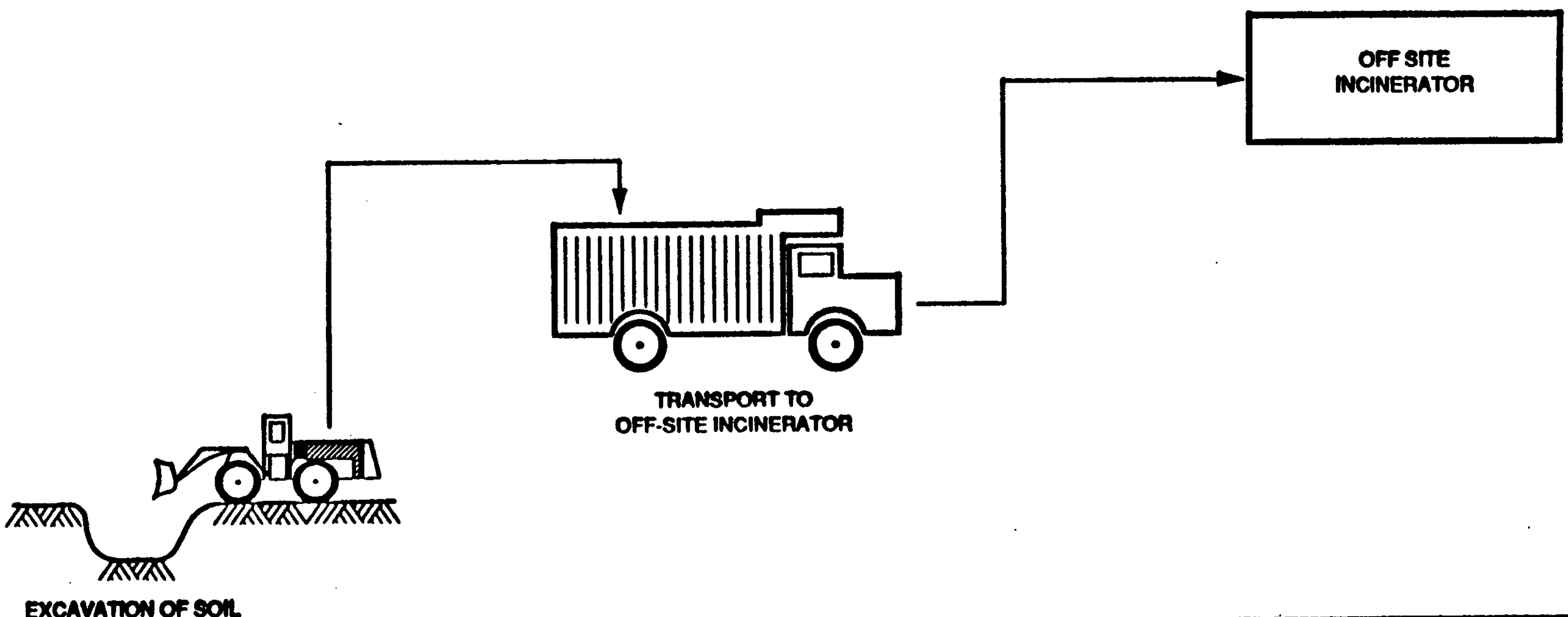
USATHAMA

Hamilton Army Airfield

S8: LOW TEMPERATURE THERMAL DESORPTION

SOIL REMEDIAL ALTERNATIVE

ENGINEERING-SCIENCE



USATHAMA

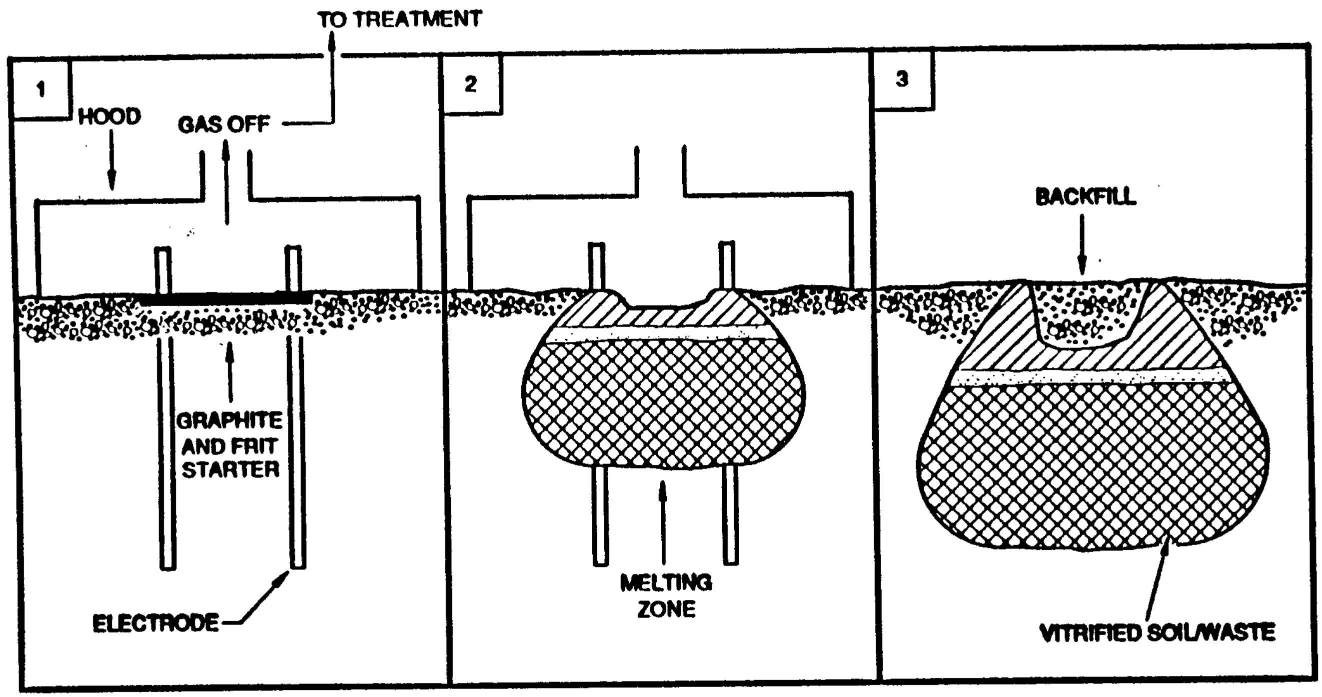
Hamilton Army Airfield

S9: OFF SITE INCINERATOR

SOIL REMEDIAL ALTERNATIVE

C203-07.R0 8/21/91

ENGINEERING-SCIENCE



SOURCE: Battelle Pacific Northwest Laboratories

C283-14.R0

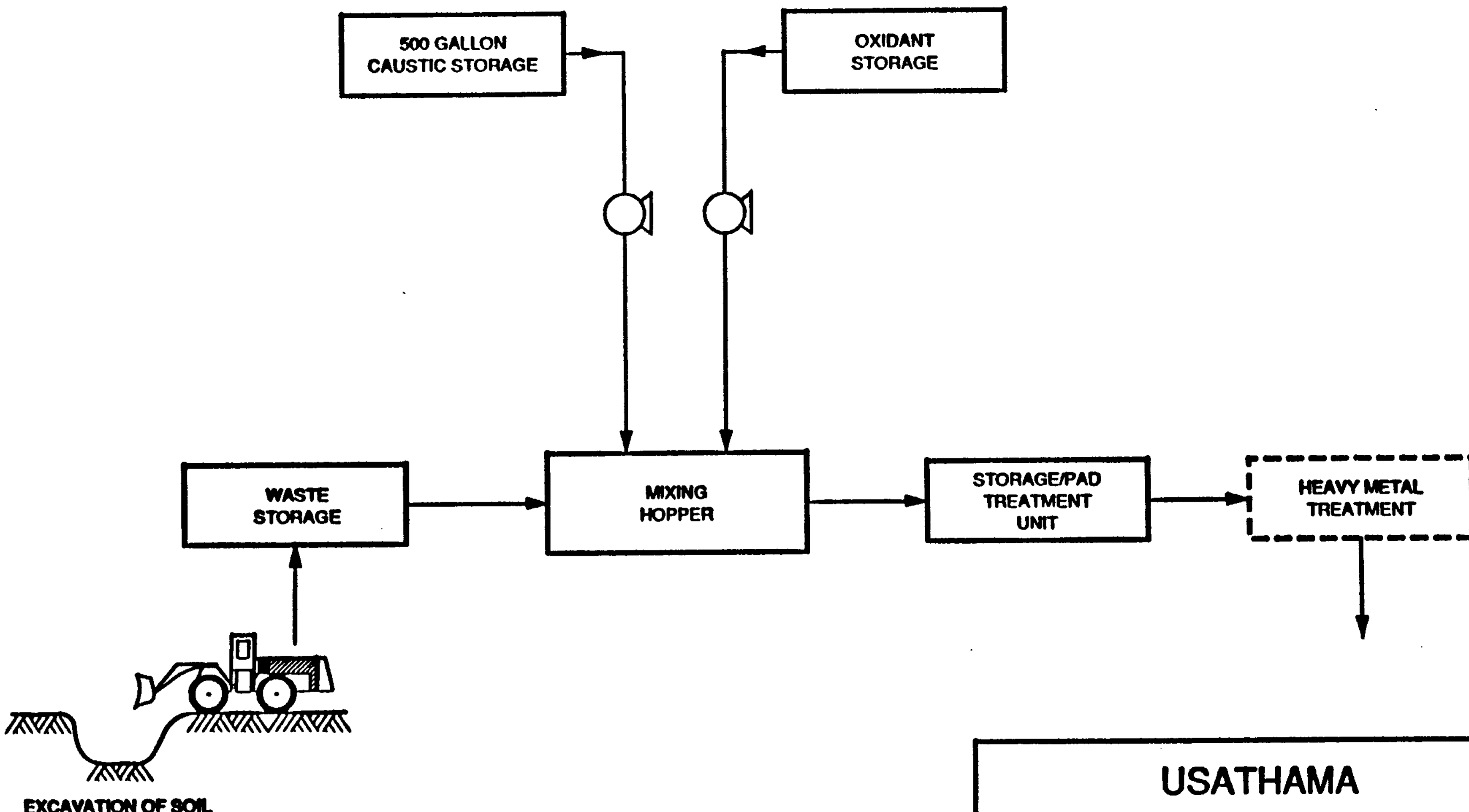
USATHAMA

Hamilton Army Airfield

S10: IN SITU VITRIFICATION

SOIL REMEDIAL ALTERNATIVE

ENGINEERING-SCIENCE



USATHAMA

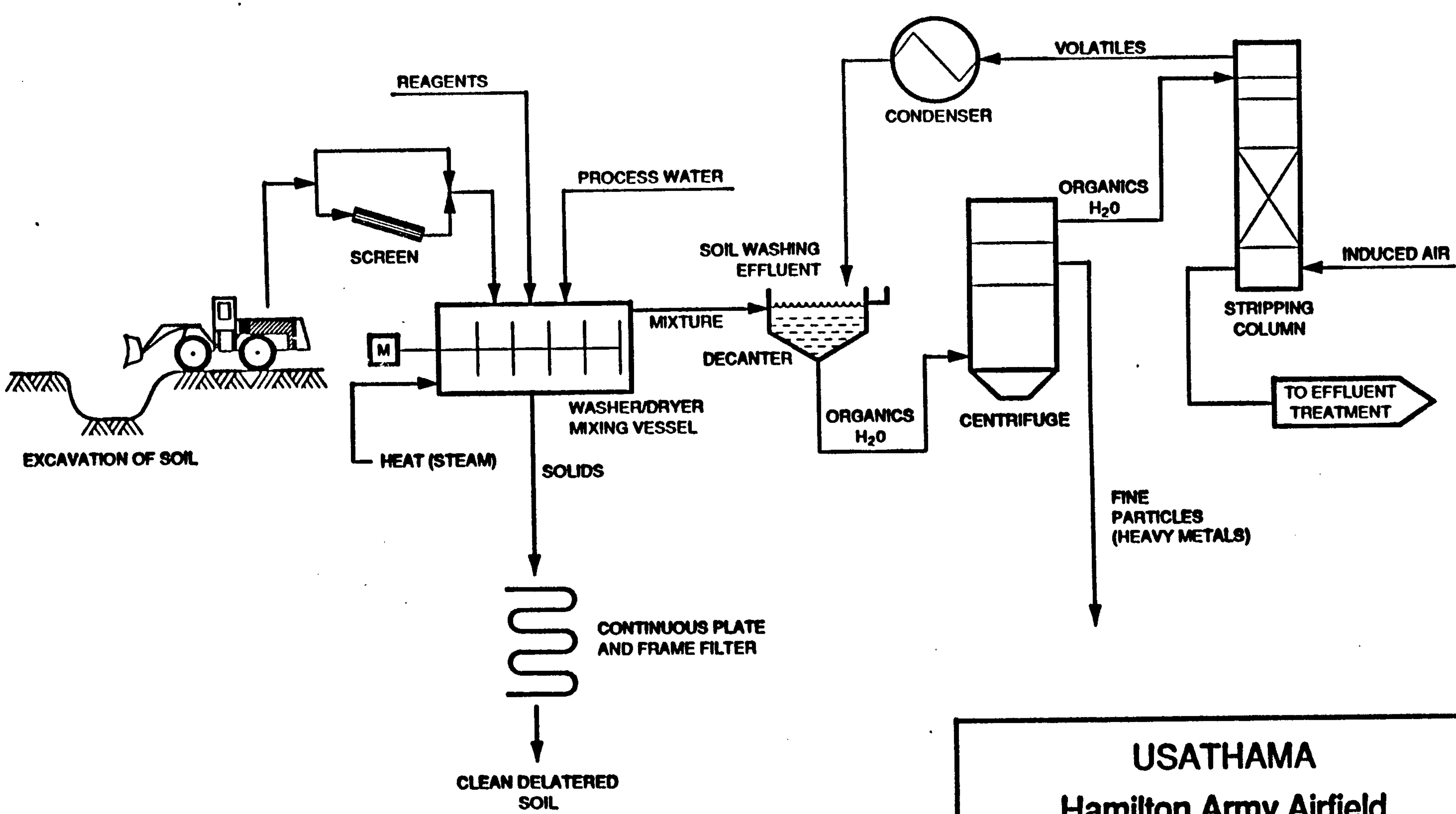
Hamilton Army Airfield

S11: CHEMICAL OXIDATION

SOIL REMEDIAL ALTERNATIVE

C206-10.R0 9/6/91

ENGINEERING-SCIENCE

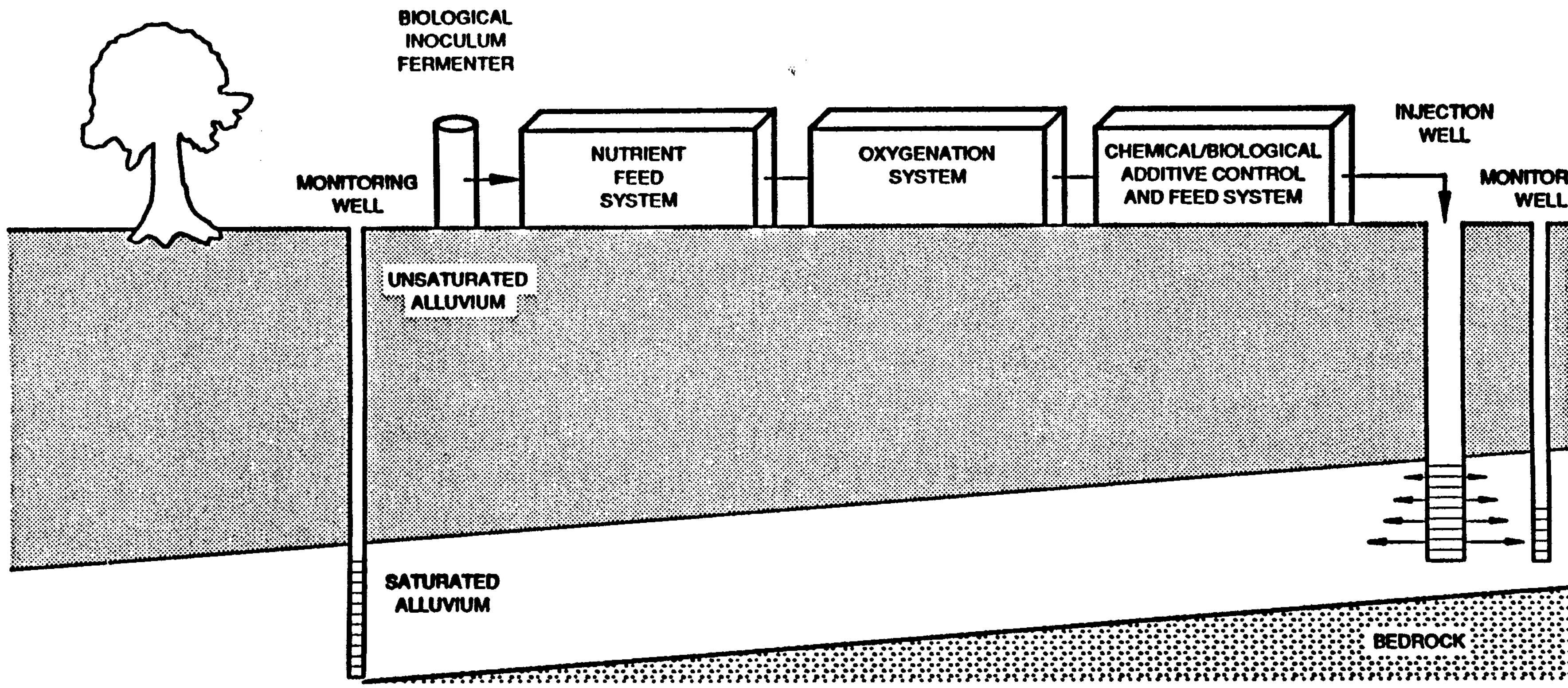


USATHAMA
Hamilton Army Airfield

S12: SOIL WASHING

SOIL REMEDIAL ALTERNATIVE

C203-03.R0 8/19/91

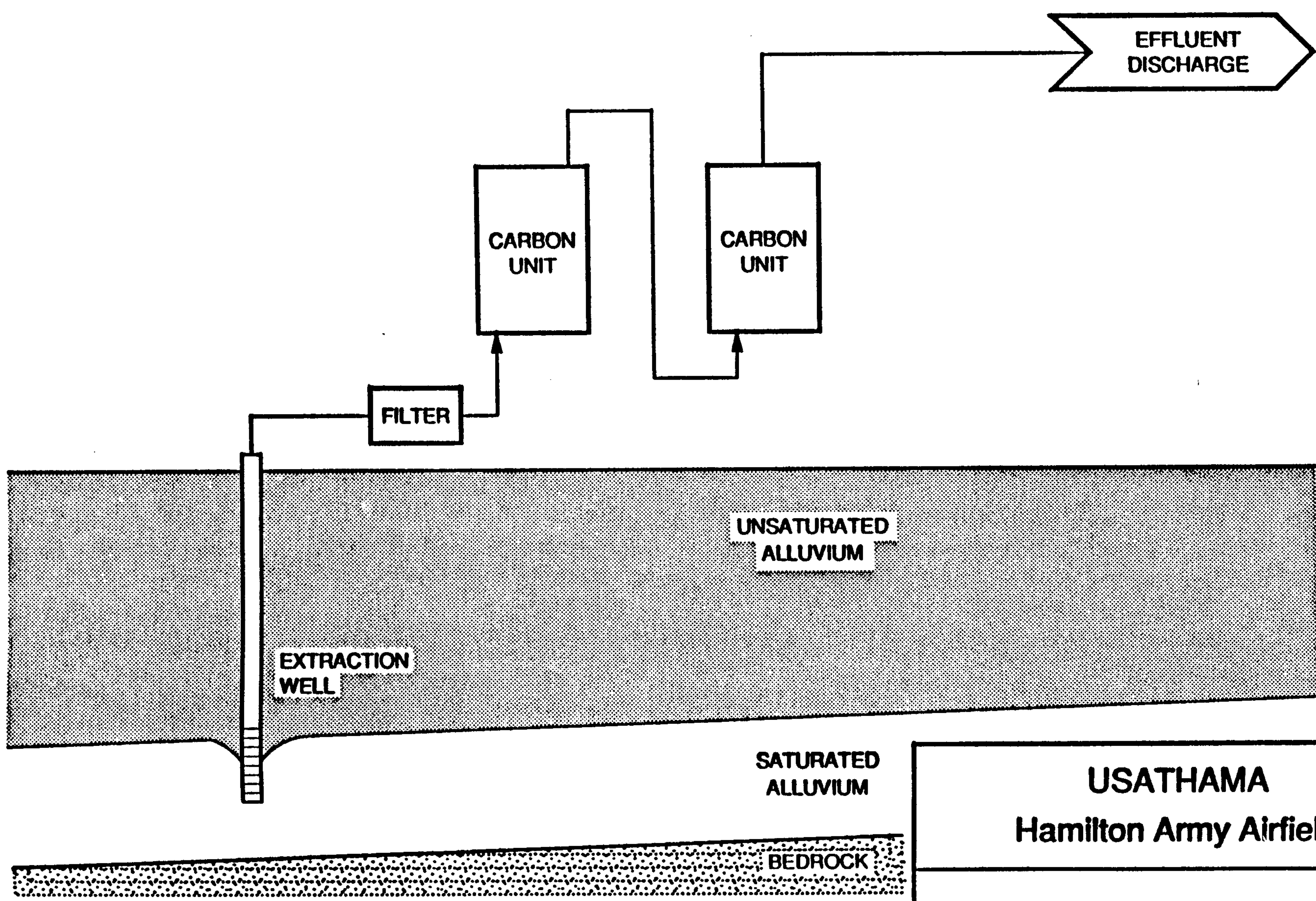


SOURCE: Ecova Corp.

USATHAMA
Hamilton Army Airfield

GW2: BIOREMEDIATION (IN-SITU)

GROUNDWATER REMEDIAL ALTERNATIVE

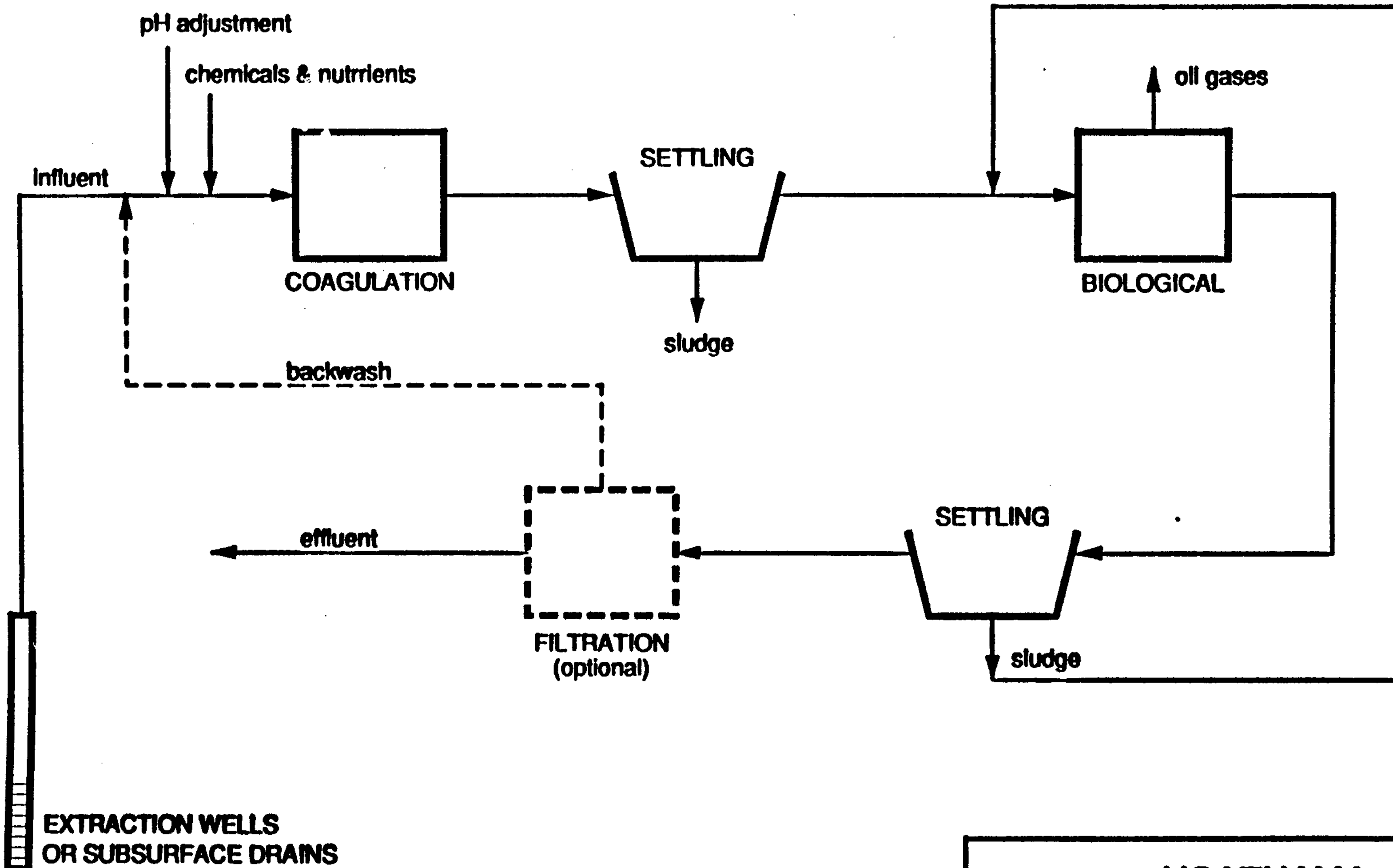


USATHAMA
Hamilton Army Airfield

GW4: CARBON ADSORPTION

GROUNDWATER REMEDIAL ALTERNATIVE

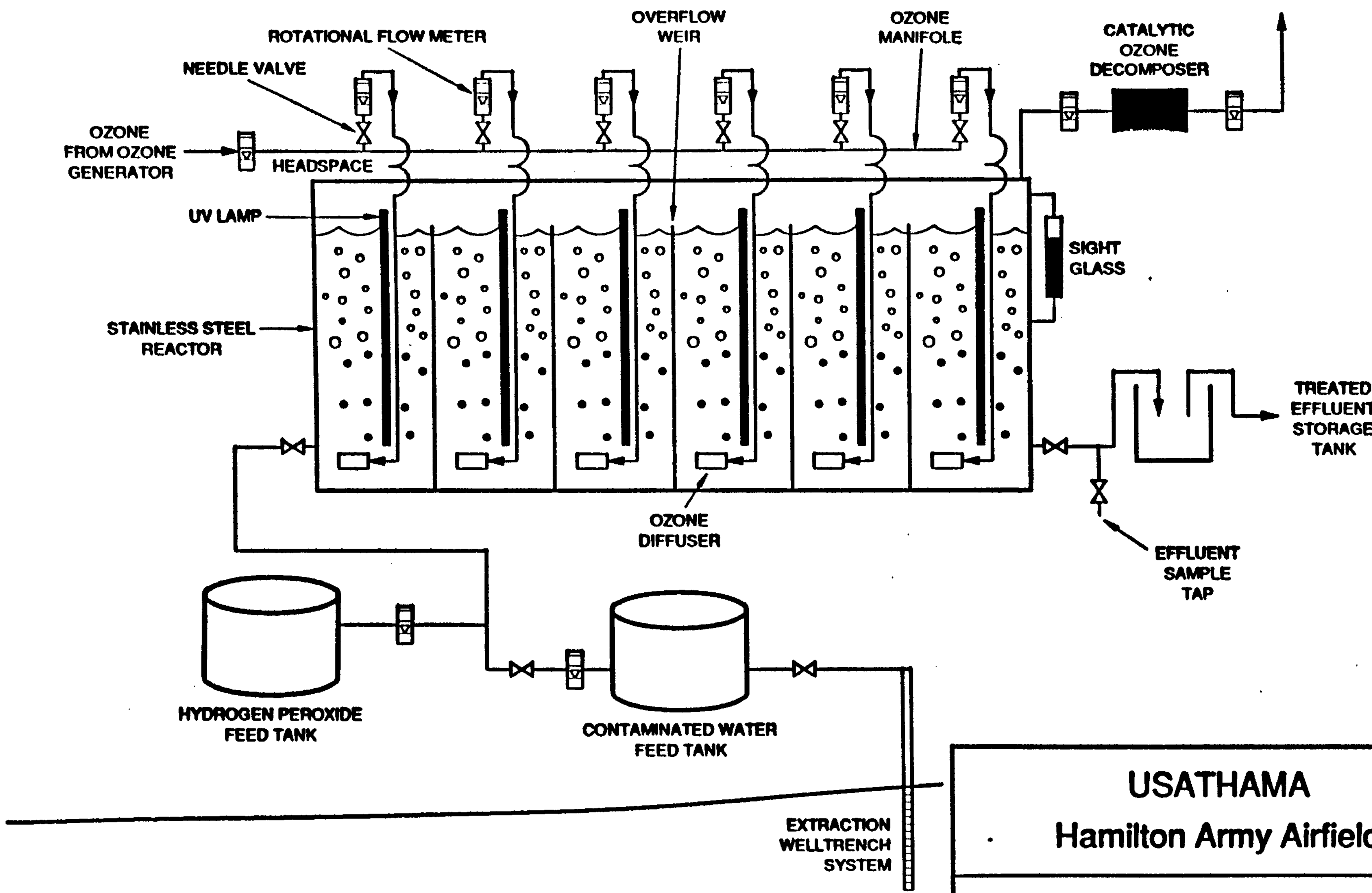
ENGINEERING-SCIENCE



USATHAMA
Hamilton Army Airfield

GW5: BIODEGRADATION UNIT
GROUNDWATER REMEDIAL ALTERNATIVE

ENGINEERING-SCIENCE



USATHAMA

Hamilton Army Airfield

GW6: UV OXIDATION

GROUNDWATER REMEDIAL ALTERNATIVE

C204-11.R1 9/19/91

ENGINEERING-SCIENCE

APPENDIX F

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - LOCATION AND ACTION SPECIFIC

APPENDIX F

Table F-1 Selected Location-Specific Potential ARARs

Table F-2 Selected Action-Specific Potential ARARs

TABLE F-1

SELECTED LOCATION-SPECIFIC POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR HAA SITES

Location	Requirements	Prerequisites for Applicability	Citation
CLEAN AIR ACT			
Within 100-year flood-plain	Facility must be designed, constructed, operated, and maintained to avoid washout	RCRA hazardous waste; treatment, storage, or disposal	40 CFR 264.18(b)
Within floodplain b/.	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood prone areas.	Protection of floodplains, b/ (40 CFR 6, Appendix A); Fish and Wildlife Coordination Act (16 USC 661 et seq.); 40 CFR 6.302.
RESOURCE PROTECTION STATUES			
Historic district, site, building, structure, or object.	Avoid impacts on cultural resources. Where impacts are unavoidable, mitigate through design and data recovery.	Properties listed in the National Register of Historic Places, or eligible for such listing.	National Historic Preservation Act (NHPA) 16 CFR Par 470, et. seq.
Critical habitat of/or an endangered or threatened species.	Identify activities that may affect listed species.	Species or habitat listed as endangered or threatened.	Endangered species Act (ESA) 50 CFR section 402.04
	Actions must not threaten the continued existence of a listed species.		50 CFR section 402.01
	Actions must not destroy critical habitat.		50 CFR section 402-01
Wetlands	Action to avoid adverse effects, minimize potential harm and preserve and enhance wetlands to extent possible.	Requires action to minimize the destruction, loss or degradation of wetlands.	Executive Order 11990 Protection of Wetlands 40 CFR 6, Appendix A, Clean Water Act Section 404 40 CFR Parts 280 33 CFR Parts 320-330

TABLE F-1 (continued)

Location	Requirements	Prerequisites for Applicability	Citation
RESOURCE PROTECTION STATUES			
Wild and Scenic Rivers	Determine if project will affect the free-flowing characteristics, scenic, or natural values of a designated river;	Any river, and the bordering or adjacent land, designated as "wild and scenic or recreational."	Wild and Scenic Rivers Act (WSRA) 36 CFR section 297.4
	Not authorize any water resources project or any other project that would directly or indirectly impact any designated river without notifying DOE or Forest Service.		
Coastal zone or an area that will affect the coastal zone.	Federal activities must be consistent with, to the maximum extent practicable, State coastal zone management programs.	Wetland, flood plain, estuary, beach, dune, barrier island, coral reef, and fish and wildlife and their habitat, within the coastal zone.	Coastal Zone Management Act (CZMA) 15 CFR section 930.30
	Federal agencies must supply the State with consistency determination		15 CFR section 930.34 (CZMA)
Wilderness Area	The following are not allowed in Wilderness area: • commercial enterprises • permanent roads, except as necessary to administer the area • motor vehicles • motorized equipment • motorboats • aircraft • mechanized transport • structures or buildings	Any unit of the National Wildlife Refuge System.	Wilderness Act (WA) 50 CFR section 35.5

TABLE F-2

SELECTED ACTION-SPECIFIC POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR HAA SITES

Action	Requirements	Prerequisites for Applicability	Citation
CLEAN AIR ACT **New Source Performance Standards**			
Incineration (general)	Particulate emissions shall be less than 0.08 grains per dry standard cubic foot corrected to 12% carbon dioxide.	Incinerator burning solid waste, more than 50% of which is municipal-type waste, for the purpose of reducing waste volume by removing combustible matter.	40 CFR section 60.52 (CAA)
Storage of Petroleum Liquids	Floating roof, vapor recovery system, or their equivalents.	Storage vessel constructed after 6/11/73 and prior to 5/19/78 having storage capacity greater than 40,000 gallons, storing petroleum liquids with vapor pressure equal to or greater than 1.5 psia.	40 CFR section 60.112 (CAA)
	Floating roof or vapor recovery system.	Storage vessels constructed after 5/18/78 having storage capacity greater than 40,000 gallons, storing petroleum liquids with vapor pressure equal to or greater than 1.5 psia.	40 CFR section 60.112(a) (CAA)
TOXICS AND PESTICIDES			
Disposal of Pesticides	Unacceptable disposal methods: • Those inconsistent with label • Open dumping • Open burning • Disposal into any body of water • Those inconsistent with applicable law		Federal Insecticide Fungicide and Rodenticide Act (FIFRA) 40 CFR section 165.7
	Incinerate pesticide at a specified temperature/dwell time that will ensure that all emissions meet requirements of CAA relating to gaseous emissions.	Incineration (recommended) of organic pesticides, except organic mercury, lead, cadmium, and arsenic.	40 CFR section 165.8(a) (FIFRA)

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	Dispose of liquids, sludges, or solid residues generated by incineration in accordance with applicable Federal, State, and local pollution control requirements. If incineration facilities are not available, dispose of pesticides by: • Burial in a designated landfill • Chemical degradation and burial • Storage • Well injection, if all other alternatives are more harmful to the environment		40 CFR section 165.8(1) (FIFRA)
	Chemically or physically treat pesticides to recover heavy metals then incinerate the pesticides i noncompliance with CAA. If appropriate treatment and incineration are not available, the pesticides may be: • Chemically degraded and buried • Stored • Injected into the ground only if there is no alternative offering more protection to the environment	Incineration (recommended) of metallo-organic pesticides (except mercury, lead, cadmium, or arsenic compounds).	40 CFR section 165.8(b) (FIFRA)
	Chemically deactivate pesticide and recover the heavy metals. If chemical deactivation facilities are not available, encapsulate the pesticide and bury it. Store pesticide if neither deactivation nor burial area available.	Treatment recommended for organic mercury, lead, cadmium, arsenic, and all inorganic pesticides.	40 CFR section 165.8(c)
Disposal of Pesticide Containers and Residue	Incinerate or bury in a designated landfill.	Combustible containers that formerly held organic or metallo-organic pesticides, except organic mercury, lead, arsenic, and cadmium.	40 CFR section 165.9(a) (FIFRA)

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	Non-combustible containers must be: • Triple-rinsed. • Returned to the pesticide manufacturer for reuse if in good condition. • Returned to a facility for recycling as scrap metal if in poor condition.	Non-combustible containers that formerly held organic or metallo-organic pesticides (with exception noted above)	40 CFR section 165.9(b) (FIFRA)
	Triple puncture containers to facilitate drainage, and dispose of in a sanitary landfill.	Combustible and non-combustible containers that formerly held organic, mercury, lead, cadmium, or arsenic, or inorganic pesticides.	40 CFR section 165.9(c) (FIFRA)
Labeling of Pesticides	Label pesticides legibly, and prominently, to show: • Ingredients; • Warnings and precautionary statements; • Toxicity; • Directions for use, including storage and disposal methods.	Labeling requirements may apply when pesticides are considered products, and not RCRA hazardous wastes.	40 CFR section 162.10 (FIFRA)
Handling of Pesticides	Individuals handling certain pesticides must be State- or Federally-approved applicators.		40 CFR section 171.4 (FIFRA)
Discharge of Treatment System Effluent	<u>Best Available Technology:</u> Use of best available technology (BAT) economically achievable is required to control toxic and nonconventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis.	Point source discharge to waters of the United States.	40 CFR 122.44(a)
	<u>Water Quality Standards:</u> Applicable Federally approved State water quality standards must be complied with. These standards may be in addition to or more stringent than other Federal standards under the CWA.		40 CFR section 122.44 and State regulations approved under 40 CFR 131

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	Discharge limitations must be established at more stringent levels than technology-based standards for toxic pollutants.		40 CFR section 1f22.44(e)
	<u>Best Management Practices:</u> Develop and implement a Best Management Practices program to prevent the release of toxic constituents to surface waters.		40 CFR section 40 CFR 125.100
	The Best Management Practices program must: • Establish specific procedures for the control of toxic and hazardous pollutant spills. • Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a reasonable potential for equipment failure. • Assure proper management of solid and hazardous waste in accordance with regulations promulgated under RCRA.	Discharge to waters of the U. S.	40 CFR section 125.104
	<u>Monitoring Requirements:</u> Discharge must be monitored to assure compliance. Discharge will monitor: • The mass of each pollutant • The volume of effluent • Frequency of discharge and other measurements as appropriate		40 CFR section 122.41(i)
	Approved test methods for waste constituent to be monitored must be followed. Detailed requirements for analytical procedures and quality controls are provided.		40 CFR 136.1-136.4
	Sample preservation procedures, container materials, and maximum allowable holding times are prescribed.		

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	Comply with additional substantive conditions such as: • Duty to mitigate any adverse effects of any discharge; and • Proper operation and maintenance of treatment system.		40 CFR 122.41(i)
Discharge to Publicly Owned Treatment Works (POTW) (off-site activity)	Discharge of pollutants that pass through the POTW without treatment, interfere with POTW operation, contaminate POTW sludge, or endanger health/safety of POTW workers, is prohibited.	Indirect discharge to a POTW.	40 CFR 403.5
	RCRA permit-by-rule requirements (including corrective action where the NPDES permit was issued after November 8, 1984) must be complied with for discharges of RCRA hazardous wastes to POTWs.	Transport of RCRA hazardous wastes to POTWs by truck, rail, or dedicated pipe (i.e., pipe solely dedicated for hazardous waste [as defined in 40 CFR 264] which discharge from within the boundaries of the CERCLA site to within the boundaries of the POTW).	40 CFR 270.60
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268 (Subpart D)
	Area from which materials are excavated may require cleanup to levels established by closure requirements.	RCRA hazardous waste placed at site after the effective date of the requirements.	See Closure in this Exhibit.
Incineration	Analyze the waste feed.	RCRA hazardous waste.	40 CFR 264.341
	Dispose of all hazardous waste and residues, including ash, scrubber water, and scrubber sludge.		40 CFR 264.351

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	No further requirements apply to incinerators that only burn wastes that are listed as hazardous solely by virtue of combination with other wastes, and if the waste analysis demonstrates that no Appendix VII constituent is present that might reasonably be expected to be present.		40 CFR 264.340
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268 (Subpart D)
	Area from which materials are excavated may require cleanup to levels established by closure requirements.	RCRA hazardous waste placed at site after the effective date of the requirements.	See Closure in this Exhibit.
Incineration	Analyze the waste feed.	RCRA hazardous waste.	40 CFR 264.341
	Dispose of all hazardous waste and residues, including ash, scrubber water, and scrubber sludge.		40 CFR 264.351
	No further requirements apply to incinerators that only burn wastes that are listed as hazardous solely by virtue of combination with other wastes, and if the waste analysis demonstrates that no Appendix VII constituent is present that might reasonably be expected to be present.		40 CFR 264.340
	Performance standards for incinerators: • Achieve a destruction and removal efficiency of 99.99 percent for each principal organic hazardous constituent in the waste feed and 99.9999 percent for dioxins;	RCRA hazardous waste.	40 CFR 264.343

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	• Reduce hydrogen chloride emissions to 1,8 kg/hr or 1 percent of the BCl in the stack gases before entering any pollution control devices; and		40 CFR 264.342
	• Not release particulate in excess of 180 mg/dscm corrected for amount of oxygen in stack gas.		40 CFR 264.343
	Monitoring of various parameters during operation of the incinerator is required. These parameters include: • Combustion temperature; • Waste feed rate; • An indicator of combustion gas velocity; and • Carbon monoxide.		40 CFR 264.343
	Control fugitive emissions either by: • Keeping combustion zone sealed or • Maintaining combustion-zone pressure lower than atmospheric pressure		40 CFR 264.345
	Utilize automatic cutoff system to stop waste feed when operating conditions deviate.		
	Special performance standard for incineration of PCBs: • Achieve a destruction and removal efficiency of 99.9999 percent; • Either 2 second dwell time at 1200 degrees C° (±100) and 3 percent excess oxygen in stack gas; or 1.5 second dwell time at 1600 degrees C. and 2 percent excess oxygen in stack gas; and • For non-liquid PCBs, mass air emissions from the incinerator shall be no greater than 0.001 g. KB per kg of the PCBs entering the incinerator.	Liquid and non-liquid PCBs at concentrations of 50 ppm or greater.	40 CFR 761.70

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
Land Treatment	Prior to land treatment, the waste must be treated to BDAT levels or meet a no migration standard.	RCRA hazardous waste being treated or placed into another unit.	
	Ensure that hazardous constituents are degraded, transformed, or immobilized within the treatment zone.		40 CFR 264.271
	Maximum depth of treatment zone must be no more than 1.5 meters (5 feet) from the initial soil surface and more than 1 meter (3 feet) above the seasonal high water table.		40 CFR 264.271
	Demonstrate that hazardous constituents for each waste can be completely degraded, transformed, or immobilized in the treatment zone.		40 CFR 264.271
	Minimize run-off of hazardous constituents.		40 CFR 264.273
	Maintain run-on/run-off control and management system.		40 CFR 264.273
	Special application condition if foodchain crops are grown in or on treatment zone.		40 CFR 264.276
	Unsaturated zone monitoring.		40 CFR 264.278
	Special requirements for ignitable or reactive waste.		40 CFR 264.281
	Special requirements for incompatible wastes.		40 CFR 264.282
	Special testing and location requirements for certain hazardous wastes.	RCRA waste #s F020, F021, F022, F023, F026, F027 (dioxin-containing wastes).	40 CFR 264.283

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
Placement of Waste in Land Disposal Unit	Land Disposal Restrictions: Attain land disposal "treatment standards" before putting waste into landfill in order to comply with land ban restrictions. A treatment standard can be either: (1) a concentration level to be achieved (performance-based) or (2) a specified technology that must be used (technology-based). If the standard is performance-based, any technology can be used to achieve the standard. (See Treatment when Waste will be Land Disposed.)	Placement of RCRA hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave.	40 CFR 268 (Subpart D)
	Design and operating standards for unit in which hazardous waste is treated. (See citations at right for design and operating requirements for specific unit.)	Treatment of hazardous waste in a unit.	40 CFR 264.190-264.192 (Tanks) 40 CFR 264.221 (Surface Impoundments) 40 CFR 264.251 (Waste Piles) 40 CFR 264.273 (land Treatment Unit) 40 CFR 264.343-.345 (Incinerators) 40 CFR 264.601 (Miscellaneous Treatment Units) 40 CFR 265.373 (Thermal Treatment Units)

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
Treatment (when Waste will be Land Disposed)	Treatment of waste subject to ban on land disposal must attain levels achievable by best demonstrated available treatment technologies (BDAT) for each hazardous constituent in each listed waste, if residual is to be land disposed. If residual is to b further treated, initial treatment and any subsequent treatment that produces residual to be treated need not be BDAT, if it does not exceed value in COWE (Constituent Concentration in Waste Extract) Table for each applicable water. (See 51 FR 40642, November 6, 1986.)	Disposal of contaminated soil and debris resulting from CERCLA response actions or RCRA corrective actions is not subject to land disposal prohibitions and/or treatment standards for solvents, dioxins, or California list wastes until November 8, 1990 (and for certain first third wastes until August 8, 1990).	40 CFR 268.10 40 CFR 268.11 40 CFR 268.12 40 CFR 268.41 40 CFR 268 (Subpart D)
		All wastes listed as hazardous in 40 CFR Part 261 as of November 8, 1984, except for spent solvent wastes and dioxin-containing wastes, have been ranked with respect to volume and intrinsic hazards, and are scheduled for land disposal prohibition and/or treatment standard determination as follows: Solvents and dioxins — Nov. 8, 1986 California list wastes — July 8, 1987 One-third of all ranked and hazardous wastes — Aug. 8, 1988 Underground injection of solvents and dioxins and California list wastes — Aug. 8, 1988 CERCLA response action and RCRA corrective action soil and debris — Nov. 8, 1988 Two-thirds of all ranked and listed hazardous wastes — July 8, 1989 All remaining ranked and listed hazardous wastes identified by characteristic under RCRA section 3001 — May 8, 1990 Any hazardous waste listed or identified under RCRA section 3001 after November 8, 1984 — Within 6 mos. of the date of identification or listing.	51 FR 40641 52 FR 25760

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	BDAT standards for spent solvent wastes and dioxin-containing wastes area based on one of four technologies or combinations: for waste waters, (1) steam stripping, (2) biological treatment, or (3) carbon absorption [alone or in combination with (1) or (2)]; and for all other wastes, (4) incineration. Any technology may be used, however, if it will achieve the concentration levels specified.		40 CFR 268.30 RCRA Sections 3004(d)(3),(e)(3) 42 U.S.C. 6924(d)(3), (e)(3)
Underground Injection of Wastes and Treated Groundwater	UIC program prohibits: • Injection activities that allow movement of contamination into underground sources of drinking water which may result in violations of MCLs or adversely affect health. • Construction of new Class IV wells, and operation and maintenance of existing wells.	Approved UIC program is required in States listed under DSWA section 1422. (All States have been listed.) Class I wells and Class IV wells are the relevant classifications for CERCLA sites. Class I wells are used to inject hazardous waste, beneath the lowermost formation containing, within one quarter mile, an underground source of drinking water (USDW). Class IV wells are used to inject hazardous or radioactive waste into or above a formation which contains, within one quarter mile of the well, an underground source of drinking water.	40 CFR 144.12 40 CFR 144.13
	Class IV wells are banned except for reinjection of treated groundwater into the same formation from which it was withdrawn, as part of CERCLA cleanup or RCRA corrective action.		40 CFR 144.13(c)
	The Director of the UIC program in a state may lessen the stringency of 40 CFR 144.52 construction, operation, and manifesting requirements for a well if injection does not occur into, through, or above a USDW or if the radius of endangering influence (see 40 CFR 146.06(c) is less than or equal to the radius of the well.		CFR 144.16

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	• Report non-compliance orally within 24 hours. • Prepare, maintain, and comply with plugging and abandonment plan.	Class I wells.	40 CFR 144.28(b) 40 CFR 144.51(b)
	Monitor Class I well by: • frequent analysis of injection fluid; • continuous monitoring of injection pressure, flow rate, and volume; and • installation and monitoring of groundwater monitoring wells.	Class I wells are used to inject hazardous waste, beneath the lowermost formation containing, within one quarter mile, an underground source of drinking water (USDW).	40 CFR 144.28(g)(1)
	Applicants for Class I permits must: • Identify all injection wells within the area of review. • Task action as necessary to ensure that such wells are properly sealed, completed, or abandoned to prevent contamination of USDW.		40 CFR 144.55
	Criteria for determining whether an aquifer may be determined to be an exempted aquifer include current and future use, yield, and water quality characteristics.		40 CFR 146.4
	Case and cement all Class I wells to prevent movement of fluids into USDW, taking into consideration well depth, injection pressure, hole size, composition of injected waste, and other factors.	(See above)	40 CFR 144.28(e)(1)
	Conduct appropriate geologic drilling logs and other tests during construction.		40 CFR 146.12(d)

TABLE F-2 (continued)

Action	Requirements	Prerequisites for Applicability	Citation
	Injection pressure may not exceed a maximum level designed to ensure that injection doses not initiate new fractures or propagate existing ones and cause the movement of fluids into a USDW.		40 CFR 146.13
	Continuous monitoring of injection pressure, flow rate, and volume, and annual pressure, if required.		
	Demonstration of mechanical integrity is required every 5 years.		
	Groundwater monitoring may also be required.		
	Comply with State underground injection requirements	40 CFR 147	
	Hazardous waste to be injected is subject to land ban regulations. (See section 4.2.2.1 of this manual.) Treated groundwater that meets the definition of hazardous waste and is to be injected also is subject to land ban regulations.	40 CFR 268.2	
Waste Pile	Use a single liner and leachate collection system.	RCRA hazardous waste, non-containerized accumulation of solid, nonflammable hazardous waste that is used for treatment or storage.	40 CFR 264.251
	Waste put into waste pile subject to land ban regulations (see Appendix of this manual).		40 CFR 268.2

APPENDIX G

LEAD CLEANUP LEVEL CALCULATIONS

APPENDIX G

LEAD CLEANUP LEVEL CALCULATIONS

Because the EPA currently has no accepted toxicity values for lead ingestion, an alternative toxicity based method was used to establish acceptable lead levels in soil, sediment and, surface water. The method used is that described in Volume 7, Chapter 5 of the "Assessment of Health Risks from Inorganic Lead in Soil" prepared by the Department of Toxic Substances Control (DTSC) (July 1992). The document describes a model which predicts blood levels in adults and children following exposure to variable concentrations of lead in each media through different pathways of exposure.

At Hamilton Army Airfield, the pathways of concern for lead ingestion are incidental ingestion of surface soil, subsurface soil and sediments, dermal contact with surface soil, subsurface soil and sediments, incidental ingestion of surface water during recreation, and dermal contact with surface water during recreation. Resulting blood lead levels for adults and children from the lead levels in the media of concern at different percentiles is shown in Table G.1 and in Figure G.1.

In the method used, it is stated that:

"FDA (1990) considers the Lowest Observable Adverse Effect Level (LOAEL) to be 10 μg/dl in children and fetuses, and 30 μg/dl in adults." (p. 7)

All of the values shown in Table G.1 are below these levels. However, the values in Table G.1 assume that lead inputs from all other pathways are zero. In other words, it is assumed that no lead is in the air, food or drinking water of the receptors being exposed to soil, sediments and surface water at Hamilton Army Airfield. This assumption may tend to underestimate blood lead levels.

For example, if families picnicked at the former sewage treatment plant and ate soil with lead concentrations that are at the same level as the risk assessment (upper 95 percent of max, see Table 5.20 of the EI), 95 percent of the adults would have a blood lead level of 2.1 μg/dl or less. Likewise 95 percent of the children would have blood lead levels of 6.3 μg/dl or less. These values are cited under the 95th percentile heading in Table G.1. The blood lead levels at all the sites of known contamination are the same as that from people ingesting background soil.

To determine cleanup levels at Hamilton Army Airfield using the lead blood level method described above, a back calculation was used. The blood lead levels were set at 10 μg/dl (the most restrictive value) and the soil, sediment, and surface water concentrations that would result in a blood lead level of 10 μg/dl were then calculated.

Figure G.1

Modeled Blood Lead Levels for Children vs. Measured Soil Lead Concentrations

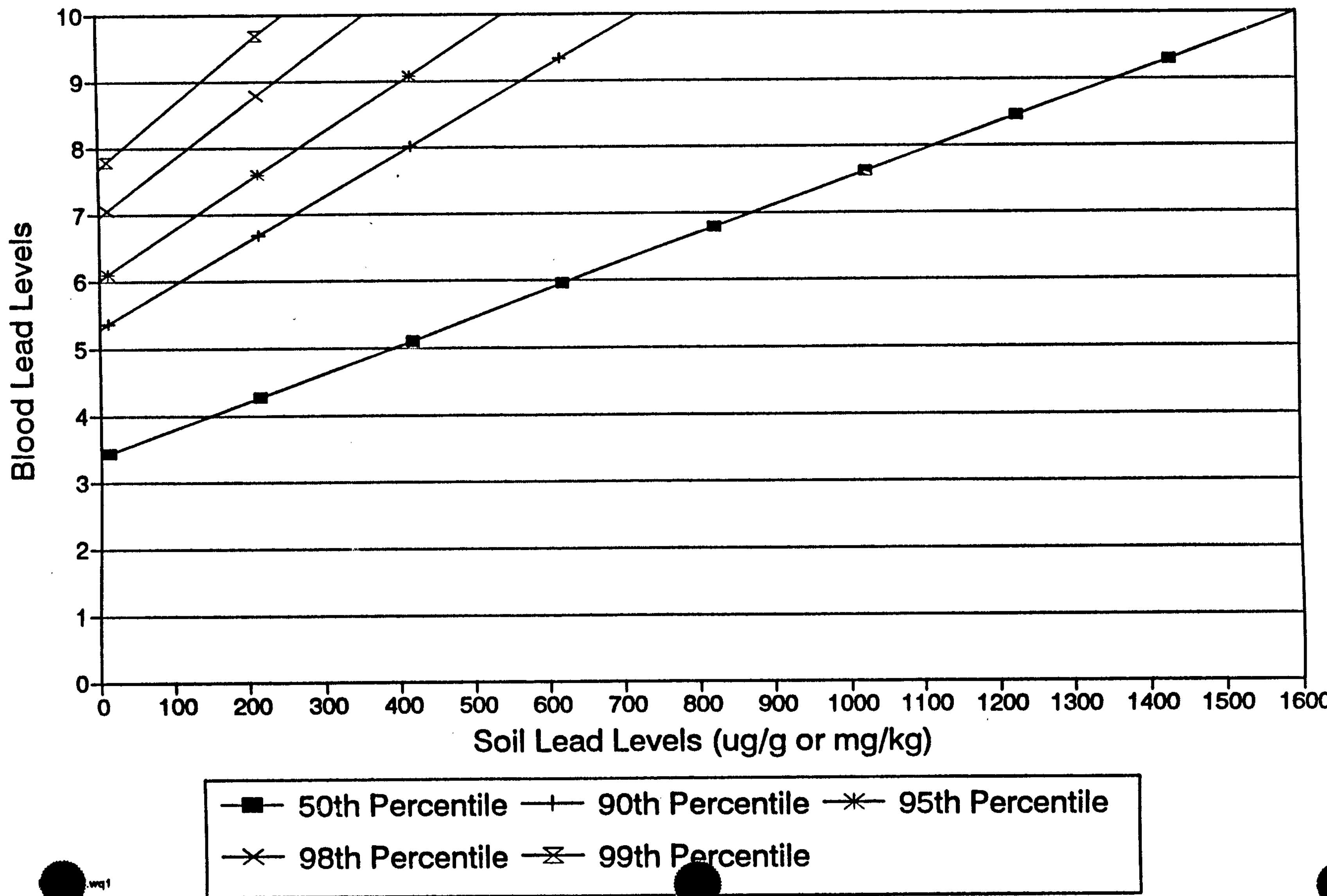


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Table G.2
Sensitivity Analysis for the DTSC
Blood Lead Model at
Hamilton Army Airfield

Lead Concen. in Soil	Lead Concentrations (ug/dl) at Different Statistical Percentiles									
	50th Percentile		90th Percentile		95th Percentile		98th Percentile		99th Percentile	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
50	1.2	3.6	1.9	5.6	2.1	6.4	2.5	7.4	2.7	8.1
75	1.2	3.7	1.9	5.8	2.2	6.6	2.5	7.6	2.8	8.4
100	1.2	3.8	1.9	6.0	2.2	6.7	2.5	7.8	2.8	8.6
250	1.3	4.4	2.1	6.9	2.4	7.8	2.7	9.1	3.0	10.0
500	1.5	5.4	2.3	8.5	2.7	9.7	3.1	11.2	3.4	12.3
750	1.7	6.5	2.6	10.1	2.9	11.5	3.4	13.3	3.7	14.7
1,000	1.8	7.5	2.8	11.8	3.2	13.3	3.7	15.4	4.1	17.0
1,250	2.0	8.5	3.1	13.4	3.5	15.2	4.0	17.5	4.5	19.3
1,500	2.1	9.6	3.3	15.0	3.8	17.0	4.4	19.7	4.8	21.6
1,750	2.3	10.6	3.6	16.6	4.1	18.8	4.7	21.8	5.2	24.0

Notes:

ug/dl – micrograms per decaliter

The above data assumes contributions of Pb from all other pathways equals zero.

Based on the DTSC, 1991 reference for the Assessment of Health Risks from Inorganic Lead in soil.

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For soil and sediment, a concentration of 535 mg/kg would result in a blood lead level of 10 μg/dl. Surface water concentration of 710 μg/L could exist during recreation before blood lead levels reached 10 μg/dl. The 95th percentile of the blood lead level calculations was used. It was assumed that the 95th percentile is conservative and is consistent with use of the upper limit of the 95th percent confidence interval in calculating reasonable maximum exposures. The contact rates assumed for soil, sediment and surface water ingestion correspond to those shown in Table 5.2 of the EI for the pathways of concern (Engineering-Science, 1993).

The model's exposure variables, however, had to be adjusted to reflect that the contact with water would occur during recreation only and not during residential use (such as drinking, showering, and dish-washing) to match those shown in Table 5.2. Specifically, the contact rate for surface water was changed to 50 milliliters per hour, the exposure time was changed to 2.6 hours per event, the exposure duration of 25 events per year was added for both child and adult residents. In addition, the skin surface areas available for contact were changed to 7,200 square centimeters per event for children and 18,200 for adults. There was no exposure scenario for base employees or construction workers.

To determine how the model used to predict blood lead levels reacted to different lead levels in soil and sediment, a sensitivity analysis was performed. In conducting the sensitivity analysis, it was assumed that level inputs from all pathways, except for soil and sediment ingestion, were equal to zero. Soil lead levels were then varied from 50 to 1,750 μg/g or mg/kg and corresponding modeled blood lead levels at varying percentiles were recorded (Table G.2). As shown in Table G.2, at approximately 250 mg/kg, blood lead levels in children, at the 99th percentile, reach the 10 μg/dl threshold criteria. At approximately 500 mg/kg, the 10 μg/dl criteria is achieved at the 95th percentile. At approximately 750 mg/kg, the threshold criteria is reached at the 90th percentile. Between 1,500 and 1,750 mg/kg, the threshold criteria is reached at the 50th percentile.

Results of the blood lead level model are given in several percentages, presumably, so the user can select an appropriate level of uncertainty. The percentiles are developed to account for the variability inherent in human metabolisms. The higher the percentile, the lower the uncertainty. At the 99th percentile, all but 1 percent of a population could be expected to have the modeled blood lead level or lower. At the 50th percentile, half the population could be expected to have the measured blood lead level, or lower.

Results of the sensitivity analysis indicate that the model yields approximately linear results as shown in Figure G.1. The modeled blood lead levels increased more or less linearly with lead levels in soil. There do not appear to be any drastic affects to blood lead levels from small (less than 50 to 100 mg/kg) increases in soil lead levels.

A sensitivity analysis similar to the one performed on soil lead levels was completed to observe how the model would react to changes in surface water concentrations. In conducting the analysis, it was assumed that lead inputs from all pathways, except exposure to surface water, were equal to zero. Exposure variables in the model were not changed to reflect that the exposure was from recreational, not residential use. Such adjustments are not necessary because only the sensitivity of the model, not the results, are being analyzed.

Table G.3
Sensitivity Analysis for the DTSC Blood Lead Model for Drinking Water at Hamilton Army Airfield

Lead Concen. in Water	Lead Concentrations (ug/L) at Different Statistical Percentiles									
	50th Percentile		90th Percentile		95th Percentile		98th Percentile		99th Percentile	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
5	1.5	2.7	2.3	4.3	2.6	4.9	3.0	5.6	3.3	6.2
10	1.7	3.1	2.7	4.8	3.1	5.4	3.6	6.3	3.9	6.9
20	2.3	3.7	3.6	5.8	4.1	6.6	4.7	7.6	5.2	8.4
30	2.9	4.3	4.5	6.8	5.1	7.7	5.9	8.9	6.5	9.8
40	3.4	5.0	5.4	7.8	6.1	8.9	7.0	10.2	7.7	11.3
50	4.0	5.6	6.2	8.8	7.1	10.0	8.2	11.6	9.0	12.7
60	4.5	6.3	7.1	9.8	8.1	11.1	9.3	12.9	10.3	14.2
70	5.1	6.9	8.0	10.8	9.1	12.3	10.5	14.2	11.5	15.6
80	5.7	7.5	8.9	11.8	10.1	13.4	11.6	15.5	12.8	17.1
90	6.2	8.2	9.7	12.8	11.0	14.5	12.8	16.8	14.1	18.5
100	6.8	8.8	10.6	13.8	12.0	15.7	13.9	18.1	15.3	20.0
110	7.3	9.5	11.5	14.8	13.0	16.8	15.1	19.5	16.6	21.4
120	7.9	10.1	12.4	15.8	14.0	18.0	16.2	20.8	17.9	22.9

Notes:

ug/L – micrograms per liter

The above data assumes contributions of Pb from all other pathways equals zero.

Based on the DTSC, 1991 reference for the Assessment of Health Risks from Inorganic Lead in water.

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Surface water lead concentrations were varied from 5 to 120 μg/L. As shown in Table G.3, at approximately 30 μg/L, blood lead levels in children, at the 99th percentile, reach the 10 μg/dL threshold. At approximately 40 μg/L, blood lead levels in children reach 10 μg/dL at the 98th percentile. At 50 μg/L, the threshold value is reached at the 95th percentile. Probably not coincidentally, the MCL for drinking water is 50 μg/L. At approximately 60 μg/L, the threshold value for blood lead levels in children is reached at the 90th percentile. The threshold blood lead level at the 50th percentile is reached at approximately 120 μg/L. Figure G.2 illustrates the effect of lead concentrations in the surface water with blood lead levels in children.

Results of the sensitivity analysis indicate that, as with lead levels in soil, the model yields approximately linear results. However, small changes in surface water concentrations (around 5 μg/L) can significantly change modeled blood lead levels. Therefore, a greater degree of precision needs to be applied to measurement of surface water lead concentrations than to soil lead measurements.

The discussion in Appendix G focuses on lead concentrations in surface water as well as soil and sediment. Groundwater lead clean up goals are based on the more conservative EPA and California MCLs (50 mg/L).

References:

Department of Toxic Substances Control 1992, Assessment of Health Risks from Inorganic Lead in Soil. Chapter 5 of Volume 7 of Guidance for Site Characterization and Multimedia Risk Assessment for Hazardous Substances Release Site.

FDA 1990, Contaminants Team, Division of Toxicological Review and Review and Evaluation, Food and Drug Administration, Public Health Services, U.S. Department of Health and Human Services; Memorandum to Elizabeth Campbell Division of Regulatory Guidance.

APPENDIX H

EPA HEALTH ADVISORIES

Table H-1
EPA Health Advisories for Chemicals of Concern Which Lack MCLs or Proposed MCLs*

	Health Advisories				
	10-kg Child			70-kg Adult	
Chemical	One-day mg/L	Ten-day mg/L	Longer-term mg/L	Longer-term mg/L	Lifetime mg/L
Boron	4	0.9	0.9	3	0.6
Naphthalene	0.5	0.5	0.4	7	0.1
Phenol	6	6	6	20	4
Silver	0.2	0.2	0.2	0.2	0.1
Vanadium	0.08	0.08	0.03	0.11	0.02
Zinc	NA	NA	NA	NA	2.1

* Thirty seven chemicals in Table 2.3 do not have published MCLs or proprosed MCLs. Of these thirty seven chemicals, twenty seven were identified as chemicals of concern in the human health risk assessment. Six of these twenty seven chemicals have published Health Advisories.

The remaining twenty one chemicals of concern from the human health risk assessment which do not have MCLs or Health Advisories include acenaphthene, acenaphthylene, aluminum, anthracene, beta-benzenehexachloride, benzo(ghi)perylene, cobalt, copper, DDD, DDT, dibenzofuran, fluoranthene, fluorene, lead, manganese, 2-methylnaphthalene, 4-methylphenol naphthalene, phenanthrene, 1,1,2,2-tetrachloroethane, and 2,4,6-trichlorophenol. Lead and copper have effective action levels of 0.015 mg/L and 1.3 mg/L, respectively.

NA - No published information is available

APPENDIX I

SHALLOW WATER EFFLUENT LIMITS

TABLE III-2A
WATER QUALITY OBJECTIVES FOR MARINE SURFACE WATERS WITH SALINITIES GREATER THAN OR EQUAL TO 5 PARTS PER THOUSAND

1. Water Quality Objectives for the Protection of Aquatic Life

Constituent	Unit	4-Day Average	Daily Average	1-Hour Average
arsenic	ug/l	36	–	69
cadmium	ug/l	9.3	–	43
chlordane*	ng/l	–	4.0	–
chromium (VI)[a]	ug/l	50	–	1100
copper	ug/l	–	–	2.9
cyanide	ug/l	–	–	5.0
DDT*	ng/l	–	1.0	–
dieldrin	ng/l	–	1.9	–
endosulfan*	ng/l	–	8.7	34
endrin*	ng/l	–	2.3	37
heptachlor	ng/l	–	3.6	–
hexachlorocyclohexane-gamma	ng/l	–	160	–
lead	ug/l	5.6	–	140
mercury	ug/l	–	–	2.1
nickel	ug/l	8.3	–	75
PCBs*	ng/l	–	30	–
pentachlorophenol	ug/l	7.9	–	13
selenium	ug/l	71	–	300
silver	ug/l	–	–	2.3[b]
toxaphene	ng/l	0.2	–	210
zinc	ug/l	86	–	95

a = This objective may be met as total chromium.

b = Instantaneous Maximum

2. Water Quality Objectives for the Protection of Human Health.

Constituent	Unit	30-day Average
Noncarcinogens		
1,2-dichlorobenzene	mg/l	18
1,3-dichlorobenzene	ug/l	2600
endosulfan*	ug/l	2.0

Source:
Water quality Control Plan Amendments
San Francisco Bay Basin
Region (2) California
Environmental Protection Agency, September 1992

TABLE III-2A (continued)

Constituent	Unit	30-day Average
endrin*	ug/l	0.8
fluoranthene	ug/l	42
mercury	ng/l	25
nickel	mg/l	4.6
toluene	mg/l	300
tributyltin	ng/l	5.0
Carcinogens		
aldrin	pg/l	140
benzene	ug/l	21
chlordane*	pg/l	81
chloroform	ug/l	480
DDT*	pg/l	600
1,4-dichlorobenzene	ug/l	64
dichloromethane	ug/l	1600
dieldrin	pg/l	140
halomethanes*	ug/l	480
heptachlor	ng/l	0.17
heptachlor epoxide	ng/l	0.07
hexachlorobenzene	pg/l	690
hexachlorocyclohexane		
alpha	ng/l	13
beta	ng/l	46
gamma	ng/l	62
PAHs*	ng/l	31
PCBs*	pg/l	70
pentachlorophenol	ug/l	8.2
TCDD* equivalents	pg/l	0.014
toxaphene	pg/l	690
2,4,6-trichlorophenol	ug/l	1.0

* = See Appendix 1 in the California Enclosed Bays and Estuaries Plan for definition of this term

mg/l = milligram(s) per liter, ug/l = microgram(s) per liter, ng/l = nanogram(s) per liter; pg/l = picogram(s) per liter

APPENDIX J

CORRESPONDENCE

Supplemental Environmental Investigations

STATE OF CALIFORNIA

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
2101 WEBSTER STREET, SUITE 500
OAKLAND, CA 94612
(510) 286-1255

RECEIVED SEP 27 1993

Major Ronald Light
Department of the Army
U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010-5401

September 24, 1993
File No. 2159.5008(JBN)

Dear Major Light,

The following comments are based on the San Francisco Bay Regional Water Quality Control Board staff's review of the Draft Final Alternatives Assessment for Hamilton Army Airfield, dated February 1993.

GENERAL COMMENTS:

1. Regional Board Shallow Water Effluent Limitations (Table IV-1A in Basin Plan Amendments, September 29, 1992) should be include as Applicable Relevant and Appropriate Requirements (ARAR's) for Hamilton. The report needs to include environmental receptors in its list of receptors for the purpose of identifying ARAR's. Presently, the report only considers Maximum Contaminant Levels (MCL's) and Allowable Limits, which are concerned with the protection of humans.

2. The cleanup goal for total petroleum hydrocarbons (TPH) in the soil should be 10 parts per million (ppm) (the detection limit) for both the wetland and the development reuse option. Pursuant to the State Water Resources Control Board's Resolution #68-16 (Statement of Policy with Respect to Maintaining High Quality of Waters in California), complete cleaning of all waste discharged and restoration of affected water to background conditions are required. Higher cleanup goals than background can be proposed with appropriate justification.

3. The detection limit for TPH in the groundwater at Hamilton should be no more than 50 parts per billion (ppb), not 100 ppb as the report uses. The figure of 50 ppb is derived from the Tri-Regional Board Staff Recommendations for Preliminary Evaluation and Investigation of Underground Tank Sites, dated August 10, 1990. This is based on a Regional Board survey of what Department of Health Services' Certified Laboratories can achieve as a detection limit for TPH in water.

4. The corresponding cleanup goal for TPH in groundwater at this site shall then be the detection limit, or no more than 50 ppb.

5. Throughout the report, the AA refers to the Environmental Investigation (EI) when discussing the nature and extent of

contamination at Hamilton. Please note that Board staff was not satisfied that the extent of the soil and groundwater contamination was fully defined in the EI. Please add, in sections where the report describes the extent of soil contamination, that in its July 26 conditional acceptance of the EI, Board staff requested that additional soil sampling be performed at the POL Area, the Pump Station, the Revetment Area, the Former Sewage Treatment Plant (FSTP), the Aircraft Maintenance Area, and the Fuel Lines, as confirmation sampling during the initial phase of the Remedial Design effort. Please add, in sections where the report describes the extent of groundwater contamination, that Board staff requested that additional groundwater monitoring be performed at the Pump Station and the Former Sewage Treatment Plant prior to remediation. Based on this additional information, the extent for soil remediation may need to be expanded. Remediation alternatives for groundwater may need to be reevaluated.

6. It is our position that the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sections 14 and 120(a)(4) govern the application of state requirements at this facility, which is not listed on the National Priorities List. Therefore, by commenting on Section 2, Identification and Screening of Remedial Technologies, of the AA, Board Staff is not conceding that we are bound by the ARAR process or criteria specified in CERCLA and the National Contingency Plan.

SPECIFIC COMMENTS:

1. Please take out the disclaimer statement which is on the page preceding the Table of Comments.

2. Section 1.2.3 This section refers to the Environmental Investigation (EI) when discussing the overall nature and extent of contamination at Hamilton. Please see general comment #5.

3. Section 2.1, page 2-1 A primary objective of remedial action at Hamilton should also include preventing potential risks to human health and the environment from contamination which presently exists in the groundwater. The first bullet item is mainly concerned with contaminants in the soil which could later leach into the groundwater.

4. Section 2.1.2, page 2-7, first paragraph Please take out the sentence, "Non-promulgated advisories or guidance documents issued by federal or state governments do not have the status of potential ARAR's." Please see general comment #6.

5. Section 2.1.2, page 2-7, last paragraph The sentence, "Thus the groundwater beneath Hamilton Army Airfield has only limited beneficial uses due to high salinity, low yield, and high total dissolved solids.", implies that only human receptors (drinking water) were considered in formulating beneficial uses,

and consequently, ARAR's. Environmental organisms should also be included when considering the beneficial uses of the groundwater. Please see general comments #1 and #6.

6. Table 2.3--Potential ARARs for Chemicals of Concern Regional Board Basin Plan Shallow Water Effluent Limitations (Basin Plan Amendments, September 1992, Table IV-1A) should be included in the California List. See general comments #1 and #6.

7. Table 2.3 The Applied Action Levels for soil contact listed as ARAR's in Table 2.3 and the Preliminary Remediation Goals (PRG's) in Table 2.4 are strictly based on the human health risk for anthracene, phenanthrene, and total xylenes. A PRG of 30,000 ppm for xylenes is way above background (non-detect) for Hamilton. Similarly, a 100 ppm PRG for anthracene and phenanthrene are unacceptable. These organic compounds could leach into the groundwater and cause widespread contamination. The soil should be cleaned up to background levels for all organic chemicals, unless otherwise justified by the Army Environmental Center (AEC) and approved by the Regional Board.

8. Table 2.4 In Table 2.4 a lead PRG of 535 ppm is unacceptable. This is much higher than the lead detected in both the background inland and wetland soil. The background levels lie between 30 and 70 ppm. (Appendix E, EI) The sensitivity analysis described in Table G.2 only considers human receptors in its lead blood-level calculations, presented in Appendix G. It does not take into account environmental receptors. The report needs to refer to California's Water Quality Standards and Their Applicability to Waste Management and Site-Cleanup, written by Jon Marshack, Central Valley Regional Board, dated August 1992. This document uses a soil cleanup level which is back-calculated from an acceptable groundwater level. For further reference, please see The Designated Level Methodology for Waste Classification and Cleanup Determination, Marshack, October 1986, and February 1991 Edition of Water Quality Goals, Marshack.

9. Page 2-22, last paragraph The cleanup goal for TPH in the soil for the wetland reuse option should be 10 ppm. Please see general comment #2.

10. Table 2.6--Summary of Contaminants Exceeding Soil or Sediment Screening Criteria, Wetland Development Option The sediment screening criteria used for nickel at both the Pump Station and the Aircraft Maintenance Area is 140 ppm. This value is much higher than the National Oceanic and Atmospheric Association's Effects-Range Medium value of 50 ppm, as given in the Sediment Screening Criterion and Testing Requirements for Wetland Creation and Upland Beneficial Reuse. (John Wolfenden and Michael Carlin, San Francisco Bay Regional Water Quality Control Board, December 1992)

11. Page 2-28, last paragraph The certified reporting limit (detection limit) for TPH in the groundwater at Hamilton should be no more than 50 ppb. This is according to the Tri-Regional Guidelines. Please see general comment #2.

12. Section 4.2.3 and Figure 4.28 Groundwater remediation should be considered at the Pump Station. The Regional Board is requiring additional groundwater monitoring during the initial part of the Remedial Design Phase. (Please see general comment #5) Results from this monitoring could require that remedial action be taken at this site. Please include some remedial options in the alternatives analysis.

13. Section 4.2.4 and Figure 4.29 Groundwater remediation should be considered at the FSTP. The Regional Board is requiring additional groundwater monitoring during the initial part of the Remedial Design Phase. (Please see general comment #5) Please include some remedial options in the analysis.

14. Table 6.1 Please add in parenthesis in the legend whether the remediation technology involves an excavation. Please do this for all 17 technologies. Since the Regional Board is asking for confirmation sampling during remediation, it would be helpful to know when an excavation will take place. It is easier to take confirmation samples during an excavation than during in-situ remediation.

15. Table 6.1 Please add as a footnote to Table 6.1 that the cost figures for soil remediation could be higher as the Regional Board does not feel that the extent of soil contamination has been fully defined at many sites. Confirmation sampling during remediation could result in more soil being treated, and thus a higher cost to cleanup. (Please see general comment #5)

16. Table 6.2 Please add that for the POL Area, the Pump Station, and the FSTP, that the remedial action suggested, and the corresponding cost, could change as a result of additional monitoring that the Regional Board requested in its July 26 conditional acceptance of the EI. Additional groundwater monitoring was requested to be done at these three sites as an initial part of the Remedial Design Phase. (Please see general comment #5)

17. Table 6.3 Please add, as a footnote to the table, that the cost figures for soil remediation for the wetland reuse option could change as a result of the confirmation sampling which will take place during remediation. (Please see general comment #5)

If you have any questions on the above comments, please contact me at (510) 286-0301.

Sincerely,

James B. Nusrala

James Nusrala
Remedial Project Manager

cc:
Fred Kintzer
Project Manager
Engineering Science
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Matthew Alix
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ENGINEERING-SCIENCE, INC.

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TEL: (510) 769-0100
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1 October 1993
Ref: NC282

California Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, CA 94612

Attention: Mr. James Nusrala

Reference: Hamilton Army Airfield, EI/AA Project
East Levee Landfill Area

Dear Mr. Nusrala:

This letter report is a response by Engineering-Science, Inc. (ES), on behalf of the U.S. Army Environmental Center (USAEC), to inquiries of the Regional Water Quality Control Board (RWQCB) regarding groundwater sampling and analysis in the East Levee Landfill Area of Hamilton Army Airfield (HAA). The pertinent references are as follows:

- In your letter of 26 July 1993, regarding approval of the HAA Final Environmental Investigation (EI) Report (Engineering-Science, 1993b), several provisions for acceptance of the EI report were stated. Provision No. 4 requested that groundwater samples be collected from the five wells at the East Levee Landfill and analyzed for total petroleum hydrocarbons (TPH).
- In a subsequent conversation with you, Mr. Fred Kintzer of ES indicated that TPH analyses were not performed on groundwater samples from the East Levee Landfill because results of previous studies indicated that petroleum hydrocarbon contamination was not a concern at this site. You requested that we provide data to support this conclusion.
- In your conversation with Mr. Kintzer, you requested that the RWQCB be provided with the results of three quarters of groundwater monitoring that were conducted outside the scope of the EI, and so were not reported in the EI report.

The following sections describe the results of quarterly groundwater sampling and summarize previously collected data pertinent to petroleum hydrocarbon contamination at the East Levee Landfill.

QUARTERLY GROUNDWATER SAMPLING

This section describes the analytical results of the three rounds (April, July and October 1991) of groundwater sampling conducted on a consecutive quarterly basis subsequent to conclusion of Phase I of the EI. In addition, the sampling results originally reported in the EI report (samples collected in January 1991) are tabulated here for comparison.

All groundwater samples collected from the five wells at the East Levee Landfill Area were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), target analyte list (TAL) metals, cyanide, and anions (bicarbonate, carbonate, nitrate/nitrite, bromide, chloride, fluoride and sulphate) using United States Army Environmental Center (USAEC) -certified analytical methods. The methods used are generally equivalent to the following United States Environmental Protection Agency (EPA) methods:

USAEC Method	EPA Method
VOCs	8240
SVOCs	8270
Metals	
19 Metals*	6010
Arsenic	7060
Lead	7421
Mercury	7470
Selenium	7740
Anions	
Major Anions**	300.0
Alkalinity	310.2
Nitrate/Nitrite	353.2
Cyanide	335.3

* 19 metals include: aluminum, antimony, barium, beryllium, boron, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, silver, sodium, thallium, vanadium, and zinc.

** Major Anions include: bromide (only analyzed during Round 2 sampling), chloride, fluoride, and sulphate.

Results of the four rounds of groundwater sampling are shown on Tables 1 through 4. In general, concentrations of target analytes in Rounds 2, 3 and 4 were comparable to concentrations detected during Round 1 (Table 4.23 in the EI report), although several metals (antimony, beryllium, boron, copper, mercury, selenium and zinc) that had not been detected during Round 1 sampling were detected during one or more of the

subsequent rounds (note that samples collected prior to Round 3 were not analyzed for boron).

Concentrations of the newly detected metals were generally close to or less than drinking water standards and saltwater aquatic criteria, where available (Table 5; Engineering-Science 1993a). Boron, for which no standards have been developed, was detected at relatively uniform concentrations in all samples, suggesting that those detects represent background concentrations. All other newly detected metals were also present in background soil samples (Engineering-Science, 1993b), and therefore may be derived from natural sources. Methyl ethyl ketone was detected at one well during Round 1 sampling but was not subsequently detected in any samples. No other organic target analytes (VOCs or SVOCs) were detected in any samples.

POTENTIAL PETROLEUM HYDROCARBON CONTAMINATION

The EI report stated that a previous study (Woodward-Clyde Consultants, 1987) had indicated the presence of low levels of petroleum hydrocarbon contamination in soil at the East Levee Landfill. These data were the result of an extensive sampling program at the landfill, but were only partially presented in the Woodward-Clyde report, and were not quantified in the EI. To provide additional information regarding the need for sampling groundwater for TPH, the original laboratory reports for these data were reviewed and are tabulated with reference to sampling locations presented in Figure 1.

Woodward-Clyde (1987) indicated that two three-part composite soil samples were collected from each of 15 trenches at the East Levee Landfill. Each composite was collected at a single depth horizon, and consisted of three samples collected from the ends and middle of each trench. As described in Attachment A, TPH was analyzed using Modified EPA Method 8015 for gasoline, jet fuel, diesel, motor oil, and various lengths of hydrocarbon chains. The detection limits were 10 mg/kg for gasoline and jet fuel, 20 mg/kg for diesel, and 50 mg/kg for motor oil and long chain hydrocarbons.

The analytical results (Table 6) indicate that a very low concentration (23 mg/kg) of diesel existed in the vicinity of trench 4, and that up to 110 mg/kg of motor oil existed in the vicinity of several adjacent trenches (trenches 2, 3, 10 and 11). It should be noted however, that the detected hydrocarbons in trench 11 were not confirmed in duplicate sampling. Petroleum hydrocarbons were not detected in any other samples. These results indicate that only sporadic, low level hydrocarbon soil contamination exists at the East Levee Landfill.

CONCLUSION

In summary, extensive soil sampling in 15 exploratory trenches was performed in 1986 at the East Levee Landfill. TPH in soil was analyzed by Modified Method 8015 for TPHg, TPHjf, TPHd, TPH as motor oil, and three hydrocarbon chain length groupings.

Out of a total of 36 samples, there were no detections for gasoline and jet fuel and only one low level detection for diesel. Motor oil was detected in four samples; two of those detections slightly exceeded the Tri-Regional Board 100 ppm recommended level for initiation of a groundwater investigation. The TPH that is present is predominantly composed of long chain hydrocarbons which are more viscous and less mobile than fuel hydrocarbons.

The above data are consistent with the lack of detections for volatile and semi-volatile organic compounds in landfill soil borings (Engineering-Science, 1993b) and in the groundwater. Therefore, we conclude that petroleum hydrocarbon contamination is not a concern at the East Levee Landfill Area and that further analyses of TPH in groundwater at this location are not warranted. Engineering-Science, Inc., appreciates the opportunity to present these additional data to the RWQCB. If you have any further comments or questions, please do not hesitate to call.

Sincerely,

ENGINEERING-SCIENCE, INC.

David S. Diamond, Ph.D., R.G.
Site Geologist

Frederick C. Kintzer, C.E.G.
Project Manager

DSD/FCK/ic
Attachment

REGISTERED GEOLOGIST
FREDERICK C. KINTZER
exp. 6/30/94
No. EG 1077
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

cc: Major Ronald Light, USAEC

REFERENCES

Engineering-Science, Inc., 1993a, Hamilton Army Airfield Draft Final Alternatives Assessment Report: Contract Purchase Order No. DAAA15-90-D-0008, February 1993

Engineering-Science, Inc., 1993b, Hamilton Army Airfield Final Environmental Investigation Report: Contract Purchase Order No. DAAA15-90-D-0008, July 1993

Water Resources Control Board, 1991, Water Quality Control Plan for Enclosed Bays and Estuaries of California: Publication 91-13WQ, April 1991

Woodward Clyde Consultants, 1987, Confirmation Study for Hazardous Waste, Hamilton Air Force Base, Novato, California: Contract No. DACA45-86-C-0008, January, 1987

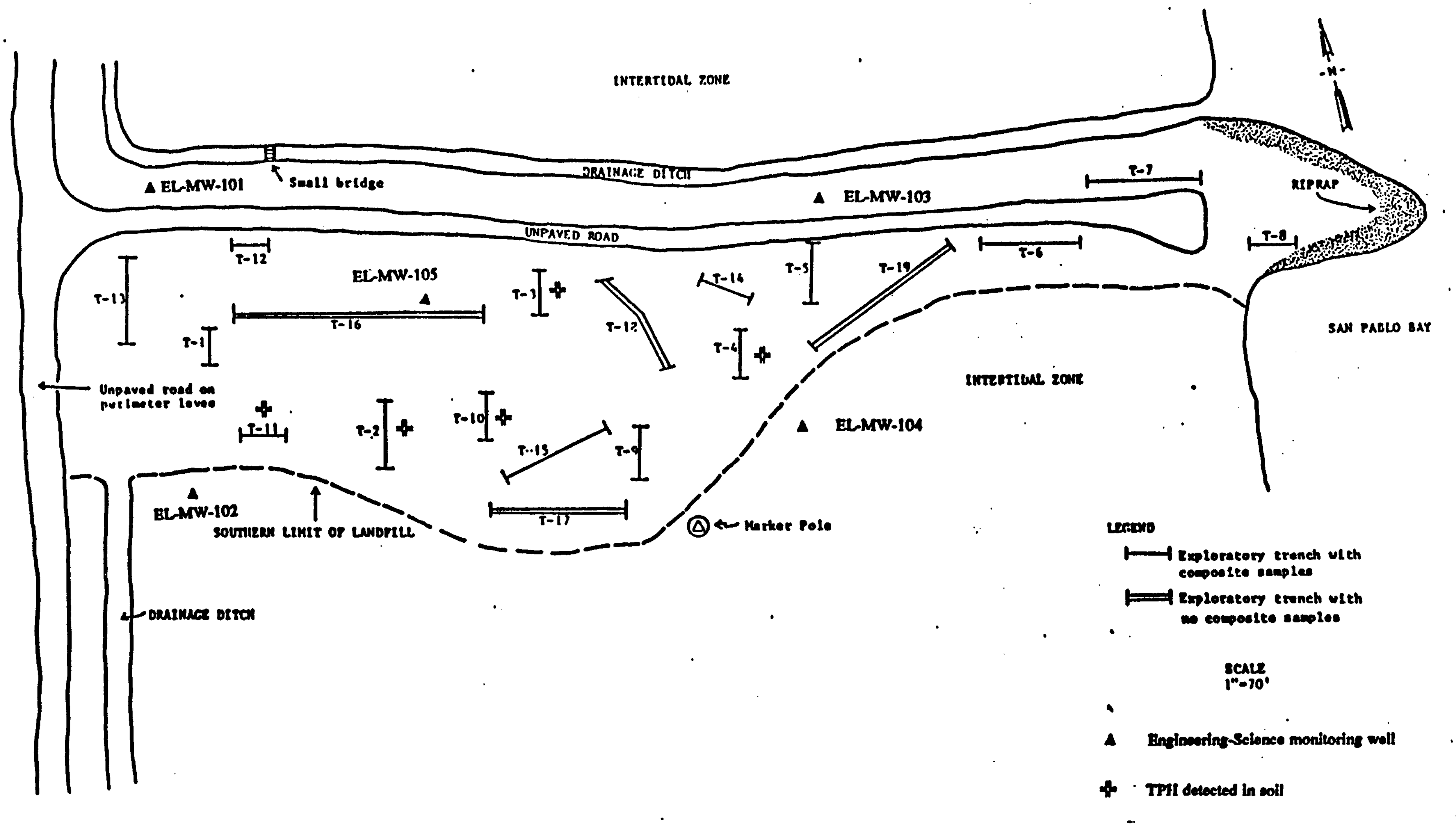

Figure 1. Location of trenches sampled by Woodward-Clyde Consultants (modified from Woodward-Clyde, 1987)

Table 1 (EI Table 4.23)
East Levee Landfill Area
Analytes Detected in Groundwater
Round 1 Sampling - January 1991

Analytes	Sample Loc.: CRL (µg/L)	EL-MW-101	EL-MW-102	EL-MW-103	EL-MW-104	EL-MW-104(dup)	EL-MW-105
		All concentrations in µg/L					
VOCs (all analytes)							
Methylethyl ketone	10.0	27.6					
SVOCs (all analytes)							
ANIONS							
Chloride	278	11,000,000	11,000,000	12,000,000	15,000,000	16,000,000	20,000,000
Fluoride	153	6,400,000	30,000	3,100,000	NA	46,000	51,000
Sulfate	175	110,000	82,000	110,000	62,000	NA	680,000
Nitrate,-ite	10.0	66.5	51	57	66	55	65
Cyanide	5.00						
Alkalinity (bicarbonates)	10,000	2,600,000	NA	NA	NA	NA	NA
Alkalinity (carbonates)	10,000		NA	NA	NA	NA	NA
METALS §							
Aluminum	112	137				NA	239
Arsenic	2.35	4.65				NA	
Barium	2.82	143	107	423	111	NA	122
Calcium	105	310,000	300,000	630,000	350,000	NA	500,000
Chromium	16.8	28.3	25.9	47.8	21.4	NA	32.8
Iron	77.5	1,370	279	418		NA	359
Lead	4.47			6.03	6.71	NA	
Magnesium	135	880,000	930,000	1,100,000	1,300,000	NA	1,800,000
Manganese	9.67	4,040	2,930	6,620	3,150	NA	4,860
Mercury	0.10					NA	
Potassium	1240	220,000	230,000	229,000	280,000	NA	390,000
Sodium	279	31,700	5,100,000	6,300,000	8,800,000	NA	12,000,000
Vanadium	27.6					NA	43.9

LEGEND

CRLs: USATHAMA (AEC) certified reporting limit concentration

(shaded) : not detected

NA (shaded) : not analyzed

§: antimony, beryllium, cadmium, cobalt, copper, nickel, selenium, silver, thallium and zinc not detected in any samples; metals were not analyzed in sample EL-MW-104 (dup)

(dup): duplicate sample

VOCs: volatile organic compounds

SVOCs: semi-volatile organic compounds

TICs: tentatively identified compounds

round_1.wk1

09/16/93

Table 2
East Levee Landfill Area
Analytes Detected In Groundwater
Round 2 Sampling – April 1991

Analytes	Sample Loc: / CRL (µg/L)	EL-MW-101	EL-MW-102	EL-MW-103	EL-MW-104	EL-MW-104(dup)
		All concentrations in µg/L				
VOCs (all analytes)						
SVOCs						
TICs	--		12	37		
ANIONS						
Bromide	407	52,000	36,000	52,000	52,000	50,000
Chloride	278	14,000,000	12,000,000	14,000,000	17,000,000	17,000,000
Fluoride	153	32,000	27,000	28,000	37,000	37,000
Sulfate	175	87,000	31,000	41,000	18,000	17,000
Nitrate, –ite	10.0	74.8	47.4	57.3	86.8	NA
Cyanide	5.00					
METALS §						
Arsenic	2.35		3.19	11.3		
Antimony	60.0	150		104	126	116
Barium	2.82	147	94.7	391	112	125
Beryllium	1.12	3.64	3.04	1.79		1.83
Calcium	105	370,000	290,000	640,000	350,000	370,000
Chromium	16.8				19.9	
Iron	77.5	1,280			407	429
Magnesium	135	1,100,000	890,000	1,100,000	1,200,000	1,300,000
Manganese	9.67	4,920	3,410	7,240	3,180	2,960
Potassium	1240	260,000	230,000	220,000	250,000	260,00[illegible]
Selenium	2.53				55.5	35.[illegible]
Sodium	279	8,700,000	6,800,000	7,400,000	9,200,000	8,600,000
Vanadium	27.6			28.1		

LEGEND

CRLs: USATHAMA (AEC) certified reporting limit concentrations

[shaded box] : not detected

NA : not analyzed

§: aluminum, cadmium, cobalt, copper, lead, mercury, nickel, silver, thallium and zinc not detected.

(dup): duplicate sample
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
TICs: tentatively identified compounds

09/14/93

round_2.wk1

Table 3
East Levee Landfill Area
Analytes Detected In Groundwater
Round 3 Sampling – July 1991

Analytes	Sample Loc: CRL (µg/L)	EL–MW–101	EL–MW–101(dup)	EL–MW–102	EL–MW–103	EL–MW–104
		All concentrations in µg/L				
VOCs (all analytes)						
SVOCs						
TICs	--		20			70
ANIONS						
Chloride	278	14,000,000	14,000,000	13,000,000	14,000,000	16,000,000
Fluoride	153	33,000	32,000	29,000	29,000	35,000
Sulfate	175	67,000	65,000	16,000	19,000	8,900
Nitrate, –ite	10.0	47.9	48.7	87.1	55.7	48.5
Cyanide	5.00					
Alkalinity (bicarbonates)	10,000	2,400,000	2,400,000*	2,600,000	2,600,000	2,600,000*
Alkalinity (carbonates)	10,000					
METALS §						
Arsenic	2.35	10.1	11.6	8.5		8.67
Barium	2.82	123	130	102	351	128
Boron	230	2,580	2,740	2,430	2,170	2,490
Calcium	105	330,000	330,000	280,000	530,000	290,000
Chromium	16.8		35.5	20.7	36	
Iron	77.5	2,030	1310	139	159	
Magnesium	135	990,000	1,000,000	900,000	1,000,000	1,100,000
Manganese	9.67	3,910	3,700	3,200	5,820	2,830
Potassium	1240	240,000	253,000	228,000	211,000	255,000
Selenium	2.53	26.8				
Sodium	279	7,000,000	7,700,000	6,700,000	6,900,000	7,800,000

LEGEND

CRLs: USATHAMA (AEC) certified reporting limit concentration

[shaded box]: not detected

NA: not analyzed

(dup): duplicate sample

VOCs: volatile organic compounds

SVOCs: semi–volatile organic compounds

TICs: tentatively identified compounds

*: These values were originally reported as 240,000 and 260,000 µg/L, respectively. Dilution factors appeared to be in error by a factor of 10, and have been adjusted accordingly in this table. Original laboratory data are stored at AEC.

§: aluminum, antimony, beryllium, cadmium, cobalt, copper, lead, mercury nickel, silver, thallium, vanadium and zinc not detected.

Table 4
East Levee Landfill Area
Analytes Detected In Groundwater
Round 4 Sampling – October 1991

Analytes	Sample Loc: / CRL (µg/L)	EL–MW–101	EL–MW–102	EL–MW–102(dup)	EL–MW–103	EL–MW–104
		All concentrations in µg/L				
VOCs (all analytes)						
SVOCs						
TICs	--	60	71	19	23	96
ANIONS						
Chloride	278	13,000,000	11,000,000	12,000,000	13,000,000	16,000,000
Fluoride	153	34,000	31,000	31,000	34,000	37,000
Sulfate	175	31,000	8,300	8,000	18,000	4,800
Nitrate, –ite	10.0	43.1	47.9	40.2	152	32.8
Cyanide	5.00					
Alkalinity (bicarbonates)	10,000	2,600,000	2,600,000	2,600,000	2,200,000	2,600,000
Alkalinity (carbonates)	10,000					
METALS §						
Aluminum	112					134
Antimony	60.0	59.8				
Arsenic	2.35	15.6	13.9	14.9	11.4	16.6
Barium	2.82	136	110	109	371	149
Beryllium	1.12	1.73	1.58	1.53	1.81	2.11
Boron	230	2,660	2,720	2,610	2,410	3,170
Calcium	105	350,000	290,000	300,000	530,000	340,000
Chromium	16.8		26.1	19.3	42	
Copper	18.8					20.[illegible]
Iron	77.5	3,330	163	225	2860	155
Magnesium	135	1,100,000	920,000	950,000	1,000,000	1,200,000
Manganese	9.67	3,220	3,350	3,250	5,610	3,040
Mercury	0.10	0.115				
Potassium	1240	233,000	228,000	218,000	215,000	270,000
Selenium	2.53			51	20	
Sodium	279	7,600,000	6,500,000	7,200,000	6,400,000	9,100,000
Vanadium	27.6				31.7	36.6
Zinc	18.0			20		

LEGEND

CRLs: USATHAMA (AEC) certified reporting limit concentration

(shaded box) : not detected

NA : not analyzed

§: cadmium, cobalt, lead, nickel, and thallium not detected.

(dup): duplicate sample

VOCs: volatile organic compounds

SVOCs: semi–volatile organic compounds

TICs: tentatively identified compounds

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round_4.wk1

Table 5
East Levee Landfill Area
Newly Detected Analytes in Groundwater*

Analytes	CRL (µg/L)	Max. Conc.	MCL	FWQC (µg/L)	WRCB		Background Soil (mg/kg)	Sampling Rounds	Wells
					Salt Life	Human			
Antimony	60	150	6	4300	--	--		2,4	1,3,4
Beryllium	1.12	3.64	4	--	--	--	1.1	2,4	1,2,3,4
Boron	230	2580	--	--	--	--	42.3	3	1,2,3,4
Copper	18.8	20.7	1300	2.9	--	--	73.2	4	4
Mercury	0.1	0.115	2	0.025 to 2.1	2.1(1hr)	0.025(30dy)	0.45	4	1
Selenium	2.53	55.5	10	71 to 6900	71(4dy)	--	1.5(1 detect)	2,3,4	2,3,4
Zinc	18	20	--	86 to 95	86(4dy)	--	161.4	4	2

LEGEND

*: Analytes detected in Sampling Rounds 2, 3 and/or 4, but not in Sampling Round 1.
CRL: USATHAMA (AEC) certified reporting limit concentration
MCL: Maximum contaminant level (Federal or State)
FWQC: Federal Ambient Water Quality Criteria
WRCB: Water Resources Control Board (Publication 91-13WQ)
--: No determined regulatory value for this analyte
(shaded box) : not detected

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Table 6
East Levee Landfill Area
TPH Analytical Results−Trench Soil Samples
June, July 1986

Sample Loc:	Depth (ft):	Gasoline	Diesel	Kerosene & Jet Fuel	Motor Oil	<C10	C11−C20	C21−C
	TPH as:	Gasoline	Diesel	Kerosene & Jet Fuel	Motor Oil	<C10	C11−C20	C21−C
	MDL (mg/kg):	10	20	10	50	10	20	50
Trench 1								
T−1−1	0.5							
T−1−1a	0.5							
T−1−2	2							
T−1−2a	2							
Trench 2								
T−2−1	0.5				64			
T−2−2	2							
Trench 3								
HT−3−1	0.5							
HT−3−2	2				58			
Trench 4								
HT−4−1	0.5							
HT−4−2	2		23					
Trench 5								
HT−5−1	0.5							
HT−5−2	2							
Trench 6								
HT−6−1	0.5							
HT−6−2	3							
Trench 7								
HT−7−1	0.5							
HT−7−1a	0.5							
HT−7−2	2							
HT−7−2a	2							
Trench 8								
HT−8−1	0.5							
HT−8−2	2							
Trench 9								
HT−9−1	0.5							
HT−9−2	3							
Trench 10								
HT−10−1	0.5				110			82
HT−10−2	1							
Trench 11								
T−11−1	0.5							
T−11−1a	0.5							
T−11−2	2							
T−11−2a	2				110			81
Trench 12								
HT−12−1	0.5							
HT−12−2	2							
Trench 13								
HT−13−1	0.5							
HT−13−2	2							
Trench 14								
HT−14−1	0.5							
HT−14−2	2							
Trench 15								
HT−15−1	0.5							
HT−15−2	2							

LEGEND

MDL: Method Detection Limit

(blank box) : not detected

NA : not analyzed

<C10: hydrocarbon chains of ten or fewer carbons

C11−C20: hydrocarbon chains of eleven to twenty carbons

C21−C36: hydrocarbon chains of 21 to 36 carbons

SOURCE: Woodward−Clyde, 1987

09/16/93

soil.wk1

STATE OF CALIFORNIA PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
2101 WEBSTER STREET, SUITE 500
OAKLAND, CA 94612
(510) 286-1255

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January 7, 1994

File No. 2159.5008 (JHG)

Mr. Matt Alix
Technical Manager
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

Subject: Requirements for additional sampling to complete the Environmental Investigation Report on Hamilton Army Air Field.

Dear Mr. Alix,

As stated in a July 26, 1993 letter, the San Francisco Regional Water Quality Control Board (SFRWQCB) accepted your Final Environmental Investigation Report (EI), with the condition that some additional sampling would be needed. On November 23, 1993 representatives of the SFRWQCB, California Department of Toxic Substances Control (DTSC) Region 1, U.S. Army Corps of Engineers (COE), and Engineering-Science, Inc. (ES), met at Hamilton Army Air Field (HAAF) to discuss the additional sampling issues. This letter summarizes the additional sampling requirements as discussed during the site visit, subsequent phone calls and at a 12/21/93 meeting of the parties indicated above.

After December 31, 1993, DTSC will be the California state lead agency for this site and comments from both DTSC and SFRWQCB will be included under a DTSC cover letter. This letter includes the technical comments of Dave Parson (Region 1 DTSC) regarding additional sampling requirements at HAAF.

GENERAL ISSUES:

1. A generalized confirmation soil sampling and analysis plan (SAP) for the POL Area, Pump Station, Revetment Area, Former Sewage Treatment Plant, Aircraft Maintenance Area, and Fuel Lines should be submitted to this office by March 31, 1994. This plan does not need to be site specific, but should indicate the conceptual methodology for determining the number and location of confirmatory samples. A list of the analysis methods to be used should be included.

   The purpose of this plan is to assure the regulatory agencies that components of the site investigation that have been deferred to the remedial design/remedial action stage, will be adequately performed.

2. In a meeting after the site visit, it was decided that the 10 parts per million (ppm) detection limit should be re-worded

to "10 ppm or lowest practical quantitation limit" for all soils and sediments contaminated with total petroleum hydrocarbons (TPH).

3. After the site visit, it was also decided that the analysis method for TPH would be method 8015 modified-extractable for lighter TPH fractions, and either 413.2 or 418.1 for heavier TPH fractions. The latter two methods utilize silica-gel cleanup and are intended to measure petroleum hydrocarbons, without quantifying non-petroleum hydrocarbons, such as animal fats. These test methods should be used for all TPH confirmatory measurements required at HAAF sites.

4. Results from all sampling and monitoring described below shall be submitted to this office by March 31, 1994, as indicated in the SFRWQCB July 26, 1993 letter.

SPECIFIC ISSUES

POL Area:

1. To provide for downgradient monitoring of the TPH-contaminated groundwater between wells PL-MW-101, PL-MW-103 and PL-MW-104, a new monitoring well should be installed about 200 feet northwest of well PL-MW-104, at the toe of the slope. Groundwater from these wells and from wells PL-MW-103, -106, -114, and -115 should be monitored quarterly. If three consecutive quarterly samples show no significant changes, then the frequency of sampling can be reduced.

Burn Pit:

1. Based on the analyses of samples from below the burn pit pad, it is apparent that contaminants have migrated through the joints between individual cement slabs. In place of further investigation at this site, it will suffice to take confirmatory soil samples during the remediation process, to determine that the Remediation Goals (which have not yet been determined) are achieved.

   Due to the low hydraulic conductivity of soils at this site, we recommend that part of the remediation include excavating at least 2 feet below the water table, waiting for the water level to equilibrate in the excavation and removing the produced liquid contaminants for proper disposal. This would be a one-time procedure to remove the most contaminated groundwater near the excavation.

Revetment Area:

1. Confirmation soil samples should be analyzed for the same suite of chemicals as the soil samples reported in the Final Environmental Investigation Report for the Revetment area.

Pump Station:

1. Three groundwater samples are required in the area downgradient (west, toward the drainage channel) of the Above Ground Tank (AST numbers 5, 6, and 7). Total Petroleum Hydrocarbons (TPH) using methods 8015 modified for purgeable and extractable fractions, Semi-Volatile Organic Compounds (SVOCs), and lead should be analyzed for each groundwater sample.

2. The presence of significant metals, SVOC and TPH contamination outboard of the levee indicates that contaminants probably have been discharged through the pump station and out onto the saltwater wetlands and mudflats. A sampling plan should be submitted to the SFRWQCB and DTSC designed to determine the horizontal and vertical extent of this contamination.

   An adequate sampling plan should probably include no less than 20 sampling locations with 2 sample depths. The locations should extend across the wetlands (between the levee and the mudflats) and from the Pump Station on the north to the former sewer outfall on the south. TPH, SVOC and metals analysis should be run for each sample. Metals analysis should include the 19 metals from the Target Analyte List (TAL).

   In order to estimate the solubility and potential mobility of inorganic contaminants at this site, a modified WET test should be run on a portion of the sediment samples. The extractant in this modified test should probably be water collected from the San Pablo Bay, since this is the water in contact with the wetland sediments. Samples with metals exceeding ten times the inorganic STLC values as listed in CCR Title 22, should be analyzed using the modified WET test.

Former Sewage Treatment Plant:

1. Four groundwater samples are required downgradient (west, toward the drainage channel) of the former sludge drying beds and the two seeps. TPH (method 8015 modified for purgeable and extractable fractions), Semi-Volatile Organic Compounds (SVOCs), and lead should be analyzed for each sample.

East Levee Landfill:

1. TPH does not need to be analyzed in the groundwater at this site. This was previously required in the July 26 letter. Regional Board staff have reviewed the October 1, 1993 proposal from Engineering-Science and concur that the low levels of VOCs and SVOCs in well EL-MW-101-105 and the low level of TPH in the trench samples performed by Woodward-Clyde, are sufficient to assure that groundwater is not contaminated by TPH at this site.

2. A soil sample is needed near the Former Burn Area at the East Levee Landfill. The sample should be analyzed for VOCs, SVOCs, TPH (purgeable and extractable), BTEX and TAL metals.

Aircraft Maintenance Area:

1. Confirmation samples will be needed at several locations after the storm drains have been flushed. Please submit a sampling and analysis plan (SAP) designed to evaluate whether contaminated sediments have been adequately removed and whether sediments from the Aircraft Maintenance Area (AMA) are impacting sediment quality in the canal that conducts stormwater from HAAF to the San Francisco Bay.

   The SAP should include sediment samples taken in the storm drains that flow into the Aircraft Maintenance Area (AMA) to determine whether upstream sources may recontaminate the AMA drains. In addition, sediment samples could be taken at the nearest sediment accumulations upstream and downstream from the point where the storm drains from the AMA empty into the large drainage canal. Some portion of the samples should be tested for metal solubility with a modified WET test.

   In order to estimate the solubility and potential mobility of inorganic contaminants at this site, a modified WET test should be run on a portion of the sediment samples. The extractant in this test should be deionized water. Samples with metals exceeding ten times the inorganic STLC values as listed in CCR Title 22, should be analyzed using the modified WET test.

2. Two additional soil samples, with TPH analysis (modified 8015 for purgeable and extractable fractions), should be taken from the area of AM-SB-10 so that the extent of the TPH contamination can be better described.

If you have questions on this letter, please call myself at (510) 687-1199 or David Parson (DTSC) at (916) 255-3668.

Sincerely,

Jack H. Gregg

Jack H. Gregg

cc:

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